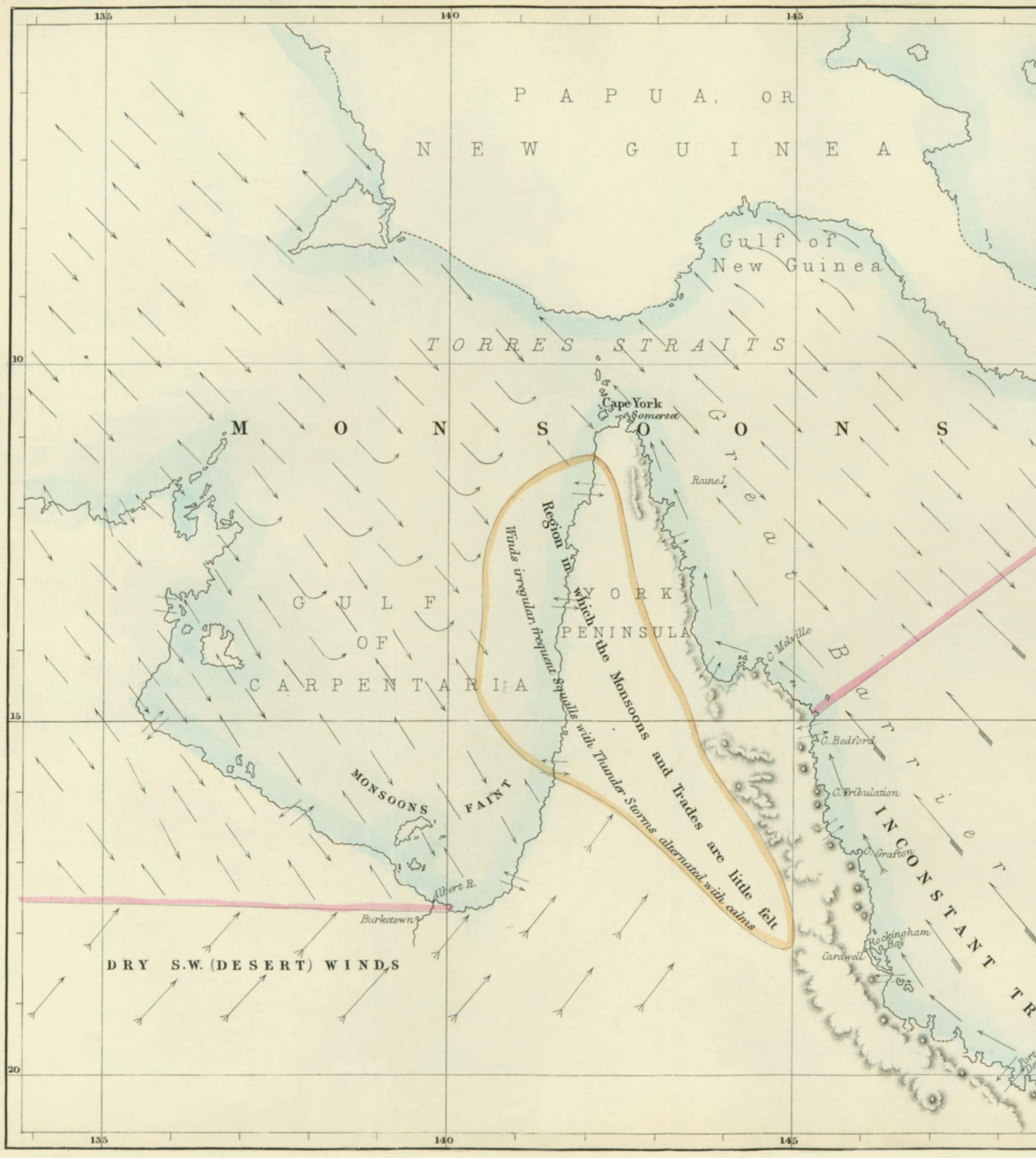
XIII. — *Notes on the Physical Geography, Climate and Capabilities of Somerset and the Cape York Peninsula, Australia.* By Dr. Alexander Rattray, M.D. (Edin.), R.N.

(*Read*, June 22, 1868.)

Two circumstances have contributed more than anything else to the rapid development of Australia, viz., the discovery of gold and the introduction of sheep and cattle farming. To the latter we are to refer a peculiarity in its settlement, observable in no other of England's numerous dependencies. Sheep and cattle farms are unusually large, many comprising hundreds of square miles. Hence, wide tracts are taken up in an incredibly short space of time. Northern Queensland has been the chief theatre of this during the past eight or ten years; and the whole of eastern and north-eastern Australia, as far as the bottom of the Gulf of Carpentaria, is now more or less completely occupied by squatting stations. As outlets for the wool, tallow, hides, and other products of these regions, and inlets for imported goods, seaports soon become necessary. But as the squatting districts are comparatively thinly peopled, one necessarily suffices for a wide extent of territory; and hence, as port after port has been opened along this coast within the past few years, they are to be found, not on neighbouring bays, but widely and often many leagues apart. Port Denison, Townsville, Cardwell, &c., along the east coast of northern Queensland and Burketown, at the bottom of the Gulf of Carpentaria, have thus sprung into existence. Four years ago the Queensland government made its latest effort in colonisation at its northern extremity, within 5 miles of Cape York, and therefore well into the tropics (lat. $10\frac{1}{2}$ s.). In this, however, as the chief objects were political and philanthropic, they were aided by the Home Government, who sent H.M.S. *Salamander*, Captain the Hon. J. Carnegie, by whom the new settlement of Somerset was founded on the 1st August, 1864.

In the two great divisions into which Australia may be divided, viz., the larger extra-tropical and the smaller inter-tropical portion, colonisation has hitherto spread principally along its eastern, western, and southern shores, *i.e.*, in those parts which possess a temperate climate. But notwithstanding the preference which the Anglo Saxon race thus shows for cool or cold regions as sites for settlement, over warmer latitudes, and the greater success which almost always, if not invariably, attends colonisation in the former, previous attempts to reclaim the north coast of this continent have not been wanting. Since 1824 no fewer than three efforts have been made in this direc-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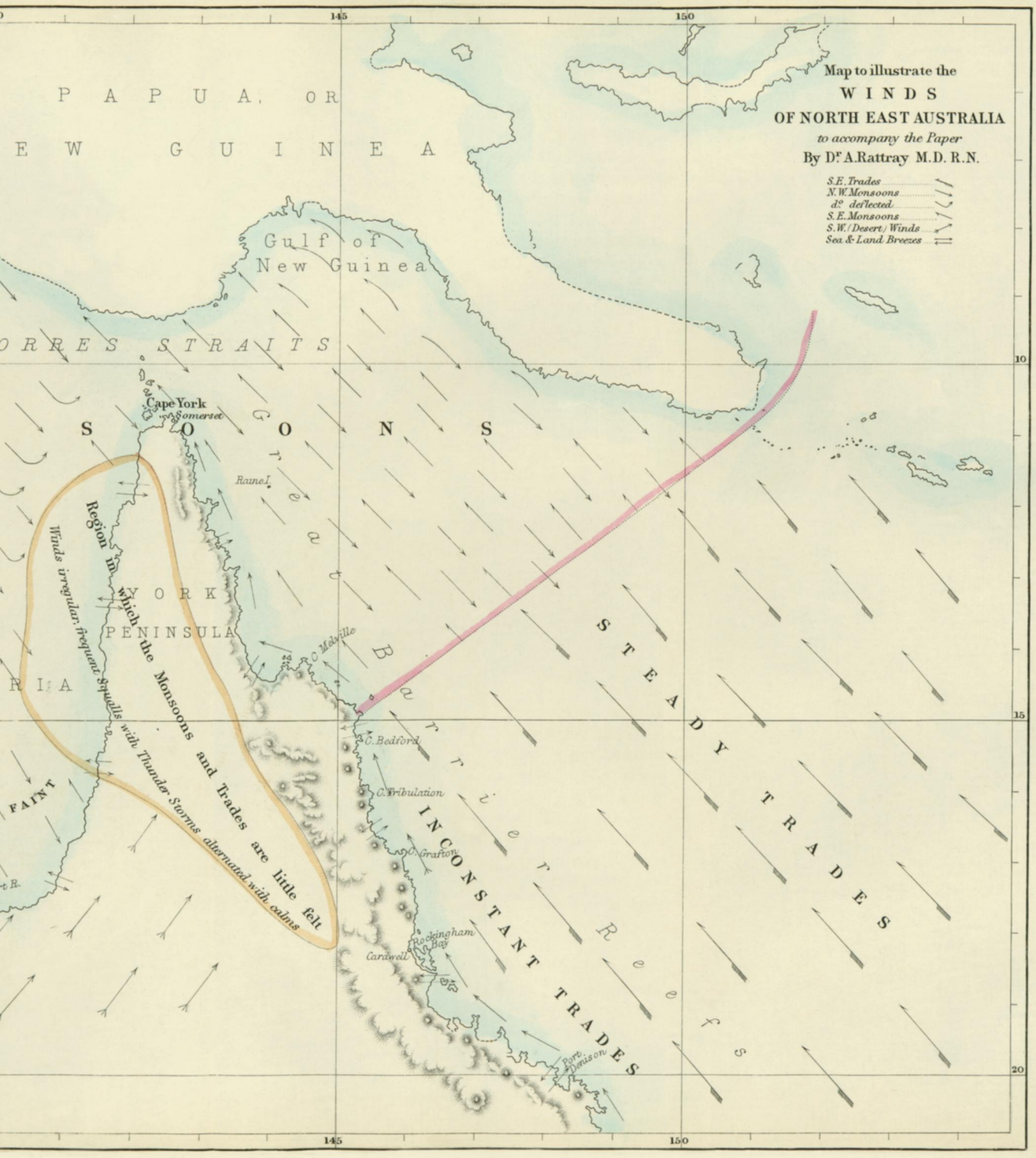
Map to illustrate the
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OF NORTH EAST AUSTRALIA
to accompany the Paper
By Dr A. Rattray M.D. R.N.
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Winds irregular frequent squalls with Thunder Storms alternated with calms
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tion under the auspices of the Home Government, who sent ships and men to plant military establishments in turn at Melville Island, Raffles Bay, and Port Essington. With all three, however, the issue proved unfortunate; and for their failure various reasons were given. Hostilities with the natives, the unhealthiness of the climate, and unfavourable reports as to their success, appear to have been the principal of the assigned causes which led to their more or less speedy dissolution; but, doubtless, in addition to local insalubrity, the inability of the other colonies of Australia, at that comparatively early and undeveloped stage of their existence, to promote and aid private emigration, and thus give them that kind of support which they most wanted, and which probably more than anything else would have contributed to their permanency by making them something more than mere military posts, conduced largely, if not principally, to their want of success and early development; while another reason was their badly-chosen geographical site. Planted, as they were, along that part of the coast which lies to the west of the Gulf of Carpentaria, they were more than 600 miles from the Barrier Reef, the most frequent scene of those disastrous shipwrecks, for the relief of which, and the aid of those crews who not unfrequently escaped death in one shape only to meet it in a worse form at the hands of the natives, the settlements were then, as Somerset is now, principally meant. The last and longest-lived of these three military establishments, that of Port Essington, was finally given up in 1849 after an existence of twelve years; and since then, until the projection of the late experiment, no further attempt has been made to colonise this seldom-visited but no doubt valuable part of Australia.

Almost contemporaneously with the settlement of Somerset the South-Australian Government founded a colony on the Adelaide River, along the north-west coast; but this has been recently abandoned. Still more lately the township of Burketon has been formed on the Albert River, at the bottom of the Gulf of Carpentaria, which still exists, though situated in a low-lying, unhealthy, marshy district, intersected by numerous creeks and small rivers, and which has recently suffered to the extent of fifty deaths in a population of 200 by "Gulf Fever," a species of bilious remittent. This and Somerset are thus at present the only settlements along the northern or tropical coast of Australia.

For various reasons, political, commercial, and philanthropic, the formation of a settlement at or near Cape York had for many years been contemplated by the Home Government, but no active steps were taken until the Queensland legislature took

the initiative and suggested its early establishment. As the new colony, unlike its predecessors, thus receives colonial as well as government aid, its prospects so far are auspicious, and its future more promising than that of its predecessors. Situated in the midst of savage and even cannibal tribes, and 1100 miles from the nearest settlement among the islands, that of Coepang in Timor; and 550 from the nearest Australian township, that of Cardwell at Rockingham Bay; 21 marines, a lieutenant, and surgeon, were sent to protect it for three years, until the dangers apt to surround new settlements during the embryo stage of their existence were safely passed, while H.M.S. *Salamander* had to make three trips yearly from Sydney to provision and protect it. Within the past few months she has been relieved by H.M.S. *Virago;* while the marines have been recalled and replaced by a small body of well-armed police, provided by the Queensland government.

Established now for three and a half years, we can judge more accurately than at first of its probable future, and whether the objects held out in its settlement are likely to be realised, *e.g.*:—

1st. There appears reason to doubt if it will ever become a second Singapore, as many anticipated, either in population or traffic. At present there is only one small squatting station. The withdrawal of the marine force has reduced the number of inhabitants to about sixteen, chiefly employés and their families. A few small coasting craft trading to the Gulf or engaged in trepang fishing, occasionally touch here; but ordinary merchant vessels, of which from 50 to 80 pass through Torres Strait yearly from the southward, seldom call, unless specially chartered. Recently, from one or other of the ports in the south they do not require supplies, nor if they did could they procure them, as there are no provision or other stores, and the water is scanty and bad; and to anchor in the 3 or 4 knot current of the Albany Pass would be not only an unnecessary delay, but unsafe and troublesome. It is necessary to state, however, that, like other places, Somerset has shared in the depression attending the late monetary crisis in Queensland, and suffered from the temporary stoppage of the line of mail steamers connecting Sydney, &c., with Batavia, India, and China, that made it a port of call; and there are grounds for believing that it may yet be a place of some importance.

2nd. It may be useful as a coal depôt for Her Majesty's Navy and the mercantile marine, especially mail steamers running between the Australian colonies and the marts of Southern and Eastern Asia by the Torres Strait route, a service which the Queensland government, in conjunction with those of

Victoria, South Australia, Tasmania, and New Zealand, are now making strenuous efforts to re-establish.

3rd. Politically it may prove important as a naval rendezvous, where Her Majesty's ships may command the traffic through Torres Strait in the event of war with any other great power.

4th. As a port of safety for the crews of vessels wrecked in Torres Strait, or on the adjacent Barrier Reef, or any of the numerous passages through it, e.g., Bligh's or Raine Island entrance, it will be more convenient and of easier access than its predecessor, Port Essington, which was too distant from the usual scene of such disasters. Three crews (forty men) of ships lost within 200 miles of Somerset were rescued by the settlement during 1866, and conveyed southward by H.M.S. *Salamander*. Singular to say, though all three were British, only one knew of the existence of Somerset, and the other two reached it by mere accident.

5th. As head-quarters for the prosecution of Beche-de-mer fishing on the extensive coral reefs of the adjacent seas, it has already proved invaluable.

6th. At a future day it may become developed as a depôt for trade with the still unexplored and little-known Papua; a company to examine and settle which was lately formed at Sydney, but the project proved abortive.

7th. It can never be either an agricultural or a pastoral place, for there is little back country, and what exists is of indifferent character, rocky and poor, and so unfit for either purpose that Somerset will long have to derive its supplies of food, &c., chiefly from abroad, and will never be able to export those of home growth, or produce either cattle, sheep, tallow, hides, cotton, sugar, rice, &c., in such abundance as may the settlements further south.

8th. With little back country, no internal resources (mineral or otherwise), and few inhabitants either to supply with imports or furnish articles for exportation, its trade, at least until commerce becomes developed with Papua and other islands of the Eastern Archipelago, can only be a transit traffic, like that of Galle, Aden, Suez, and similar places, which are little else than ports of call for mail steamers and merchantmen.

9th. As the centre of a new and wide mission-field, as yet occupied by only one delegate and an assistant, sent by the Society for the Propagation of the Gospel, amid races still little influenced by demoralising intercourse with white men, and comprising, not only the natives of North Australia, but those of Papua and the intervening islands—the mystery that still hangs over whom may yet be first dispelled by the missionary—

Somerset is a station to which too much interest and importance cannot be attached.

Eastern Australia may be said to consist of two parts; one well-known, the other almost a "terra-incognita." New South Wales and Queensland, long occupied, are more or less densely settled as far as the Gulf of Carpentaria; but the Cape York Peninsula beyond has been only imperfectly explored by Leichhardt, who crossed its southern part on his way to Port Essington; by Kennedy, who almost reached its northern extremity by skirting its mountainous and river-intersected eastern coast; and more lately and successfully by the Jardines, who by following a better route along the comparatively level land found westward of the mountain range, arrived safely at Somerset, near Cape York. The principal topographical feature of Australia regarded as a whole is, that it is essentially a flat continent, consisting of an extensive low-lying scantily-watered interior, comprising stony or sandy deserts, with an occasional patch of fertile land and hills, often isolated and rising to no great height: and of high land which skirts the coast and shows itself prominently in two mountain ranges, one in Western Australia, short and of no great height, the other longer and loftier, which forms the backbone of Eastern Australia. The latter, commencing near Cape Howe, runs northward at a distance of 50 to 100 miles from the sea, materially modifying the topography, and forming one of the principal features in the scenery of this district. In New South Wales and Southern Queensland their height varies from 2000 to 3000 feet. Further north they skirt the coast 30, 20, or even 10 miles inland, and attain their greatest altitude of 4000 or 5000 feet near Cape Tribulation, where they appear to rise abruptly from the shore. Viewed from seaward, nowhere along the entire eastern seaboard of Australia, does finer scenery exist or apparently better land than from Port Denison to Cape Bedford; a feature especially noticeable in the vicinity of Cape Tribulation, and the range which culminates in the highly picturesque Peter-Botte (3311 feet), with its sloping sides wooded from base to summit, deep well-timbered gorges, and valleys luxuriant in vegetation, all indicating great fertility of soil. Thence onward to Cape York the hills of the rapidly narrowing Peninsula gradually decrease in height, become less wood-clad, more barren and bare, and, as a range, more irregular and broken in continuity, while the land diminishes in fertility; and finally they terminate near Cape York in a series of undulating elevations seldom more than 300 feet above the sea-level.

If a straight line be drawn from Cape Grafton westward, it

will be found to touch the bottom of the Gulf of Carpentaria and isolate the Cape York Peninsula. Now it is the part thus cut off which presents this change in fertility, physical appearance, and geological character. Thus the principal features of this triangular tract on proceeding from its southern broad end to its northern pointed extremity, are first, a gradual decrease in the height of the main mountain range; and second, a progressively diminishing luxuriance in the vegetation, which, as we enter the tropics, does not assume the character we might expect from the latitude. Now the physical geography and geology of this portion of north-eastern Australia will doubtless materially influence its colonization, and the spread of settlement; and there are several reasons why it does not appear to possess advantages equal to those of many other parts of this still sparsely peopled continent: *e.g.*

1st. Its comparatively small area necessarily gives a limited back country for agricultural or pastoral farming.

2nd. Much of it is mountainous or hilly. There appears to be little really good land; and the greater part of the level country is both naturally infertile and badly watered, the rivers being few and small.

3rd. Its geological features and soil are for the most part unfavourable, as evinced by the barrenness of the country to the west of the main range, and the increasing scantiness of the vegetation along the east coast downward to Cape York, which though near the equator does not show a tropical luxuriance.

We must not therefore be over sanguine as to the future success either of the Cape York Peninsula as a whole, or its only township in this extensive area and lengthy seaboard, the sickly settlement near Torres Strait. Very visionary views were doubtless held with regard to Somerset, and the district at the extreme northern end of which it lies, prior to the formation of the former; and a future was anticipated that will probably never be realised. But although neither are so well adapted for colonisation nor likely to become of such importance as then believed, this is no more than more careful observation and forethought might have predicted. We do not disparage inter-tropical Australia as a whole however. It is a region that will probably prove of value to this southern continent; and may one day be, in some respects, the India of Australia; but for many obvious reasons, physical, geographical, and geological, Somerset and the greater part of the Cape York Peninsula are not likely to become of such importance as that more extensive and better watered tract which lies to the west of the Gulf of Carpentaria, in which there appear to be both less limited latitude for settlement and a more promising soil.

The rapidly increasing importance of Australian commerce, especially with India, China, England, and America, and the recently proved practicability of another, and in some respects better, route to the latter two than by Cape Horn, viz., by the Cape of Good Hope; give to Torres Strait and the already well-known but not yet thoroughly appreciated inner and outer Barrier-reef routes, an interest that would not otherwise be awarded them. The character and capabilities of these two ocean highways, their difficulties, dangers, and respective merits, advantages and disadvantages, have all been admirably laid down in the Admiralty Sailing Directions:—while their Survey by Blackwood, Owen Stanley, and others has rendered both passages not only easy but safe for careful navigators: and the great question now appears to be, which is preferable for sailing ships and which for steamers.

It is unquestionably the easy passage through the open Coral Sea, and the more intricate navigation of the long tortuous river-like track inside the Barrier-reef, which cause so many commanders of merchantmen to prefer the former, in which the final short cut *through* the reef, which usually lasts no longer than two or at most three days, is the only period of anxiety. But it is this brief run, whether by the Raine Island or Bligh's entrance, which constitutes the great difficulty and danger, and in which so many vessels are wrecked. Now why run such risk, when it might be avoided? The tri-annual trips of H.M.S. *Salamander* up and down the inner route during the past three years, whilst tending Somerset; the passage of other men-of-war and of mail steamers to Batavia; all safely accomplished; ought to prove the ease with which it may be traversed under sail or steam in its whole length, including its most intricate portion near Torres Strait, even in dark nights. Although the navigation has been materially benefited by the beacons placed by H.M.S. *Salamander* where most wanted it might be still further improved; and, by being more fully beaconed, buoyed, and lighted, made at least as easy as that of the English channel. But even now, could merchant-mariners be prevailed on to make trial of what is little else than coasting throughout, they would soon prefer it, notwithstanding its tediousness and intricacy, but far greater smoothness and safety, to the outer or ocean route, in which the danger of stranding or wreck is so much increased. No small part of the alleged danger of the inner route is fanciful. Its simplicity, ease, safety, and comparative celerity are obvious advantages over the outer passage, in which so much more anxiety, difficulty, and danger, both to life and property, are encountered in making the entrance and passing through it. Although the

inner route thus first requires to have its navigation rendered more easy and complete; a careful survey of those numerous "openings" and "inlets," which exist in the great Barrier-reef of Australia, like gateways of access from the open ocean to the smooth waters inside, and the busy ports that will probably ere long exist along this coast, will soon become imperative, and all the more called for as many believe that some of the larger of these would afford considerably safer, easier, and speedier passage to Torres Strait for such vessels as may continue to choose the outer route, than either the Raine Island inlet or Bligh's entrance, the two now most preferred by merchantmen.

As the salubrity and diseases of a coast or country are necessarily greatly influenced by their Physical Geography, the preceding remarks are necessary before attempting to form a just estimate of the *Climate* of North-eastern Australia, and the Cape York peninsula. Whether regarded as the centre of a circle, hundreds, nay thousands of miles wide, and stretching beyond the mainland over islands and seas little known, and some still unvisited by Europeans, or as part of a continent with regard to much of which our knowledge is still very limited, the following account of the meteorology of Somerset and the Cape York Peninsula, as yet undescribed, will be of considerable scientific interest:—while, as part of a region now being slowly colonised by Great Britain, and likely to be frequently visited by Her Majesty's ships, observations on the nature of its climate and particularly as to its Medical Climatology will appear of equal importance to medical men, and of especial value to the naval surgeon. Our knowledge of the climate of tropical Australia is very slight. That of Port Essington, which proved locally unhealthy, has been fixed by its seven years' occupation by a detachment of marines who left it in 1849: while of that of Cape York, visited for brief periods by H.M. ships *Fly* and *Rattlesnake* (1842-50), scanty though accurate notices have been published; but beyond this, until the first visit of H.M.S. *Salamander* in August, 1864, we knew little with regard to the meteorology of this region, of which it will be interesting to know whether it possesses special characteristics, or is merely regulated by laws already well known and universal.

Regarding Australia as a whole, there are several peculiarities in its physical geography which combine to modify its climate and give rise to marked local peculiarities, which it will be necessary to briefly allude to, as some of these influence the district now under consideration; *e. g.*:—

1st. Situated entirely on one side of the equator, it is, unlike every other continent, the South Polar excepted, completely water-girt; a circumstance which principally affects its coasts,

equalising their temperature, increasing the rainfall, and altering the humidity and ozone of their winds. It stands boldly out in the ocean: and, except on its north coast, which adjoins the large islands of the Eastern Archipelago, far from other great bodies of land, which therefore cannot influence its climate, except indirectly. Save on the north, the oceans which surround it are both extensive and deep, and indeed constitute the great mass of the southern hemisphere. Hence why the isotherms of this region are so straight and preserve nearly the same latitude as they circuit the globe, except where they diverge slightly to the northward from the heating effect of the pointed southern extremities of America, Africa, and Australia (Map). The isotherm of Sydney is probably the straightest of all in the southern hemisphere; and yet, curiously enough, nowhere does the equatorial belt bend more than opposite tropical Australia. Again the ocean currents which impinge on its shore are temperate, inasmuch as they flow from eastern and western sources, and run along the same latitude for many hundreds, and even thousands of miles; and none of them bring either heat from the equator or cold from high latitudes to materially modify climate, as the Gulf-Stream does the former to England, and the Iceland current the latter to Labrador.

2nd. It is essentially a flat continent, consisting of an extensive low-lying interior, encircled by a border of more elevated land, partly mountainous. Hence the rivers of the interior are few and unimportant, dwindling down to shallows and creeks during greater part of the year, rendering this part of Australia, with its alternate tracts of fair country and patches of desert, comparatively infertile as a whole. The proximity of the mountains to the sea along the east coast, and exposure to the moisture-laden ocean winds, which make their outer aspect the principal watershed, influence the humidity of the air, and rainfall, of both slopes, one of which is the dry and the other the wet, the former scantily and the latter well wooded. Along the coast the mountains never rise above 5000 feet, which makes the deposit of dew and the rainfall comparatively slight. Hence the rivers are never large, but short, rapid, and unimportant; and either flooded during the rainy season or dried up in the summer into marshy lagoons or "creeks." Again, except the Gulf of Carpentaria on the north, and the Great Australian Bight on the south, no deep bays project into the land to fertilise it, and furnish means of inter-communication. In the interior we find deserts faintly retentive of the scanty rains; while the bordering mountain chain consists of a volcanic centre flanked by sandstone, both little absorbent: and hence the dry atmosphere both of the interior and of the land near the coast, especially

during summer. Hence also the high thermometric range of the interior, its great midday heat and nocturnal cold. Thus also may we account for the fewness and unimportance of the rivers of the interior, and the usually parched nature of its soil, except for a brief period during the rainy season; and also for the occasional droughts of many parts of the coast during the dry summer. Hence also the moistureless winds which often blow in all parts of the coast region from the overheated interior. Hence also the north-west monsoons of the north coast; an indraught caused by the heat of the barren interior of tropical Australia acted on by the powerful summer sun. Hence also the dry though healthy climate, free from morbific miasms, of Australia as a whole.

The climate of the whole of Northern Australia beyond the 23rd parallel, including the Cape York peninsula, as yet little studied, is necessarily tropical throughout, differing occasionally according to latitude, &c.; and is moreover of a twofold character, inasmuch as the region which lies to the northward of lat. 15° to lat 18° s. is in the monsoon district, while all between this and the 23½° s. lat. is within the limits of the south-east trades. In both, instead of spring, summer, autumn, and winter, the year may be divided into the wet and dry seasons. Confining our attention to Somerset and that part of the Cape York peninsula which lies in the monsoon district, *i. e.* from about Cape Melville northwards, we find that the wet season corresponds to the north-west and the dry to the south-east monsoon, of the principal characteristics of which the following is a summary.

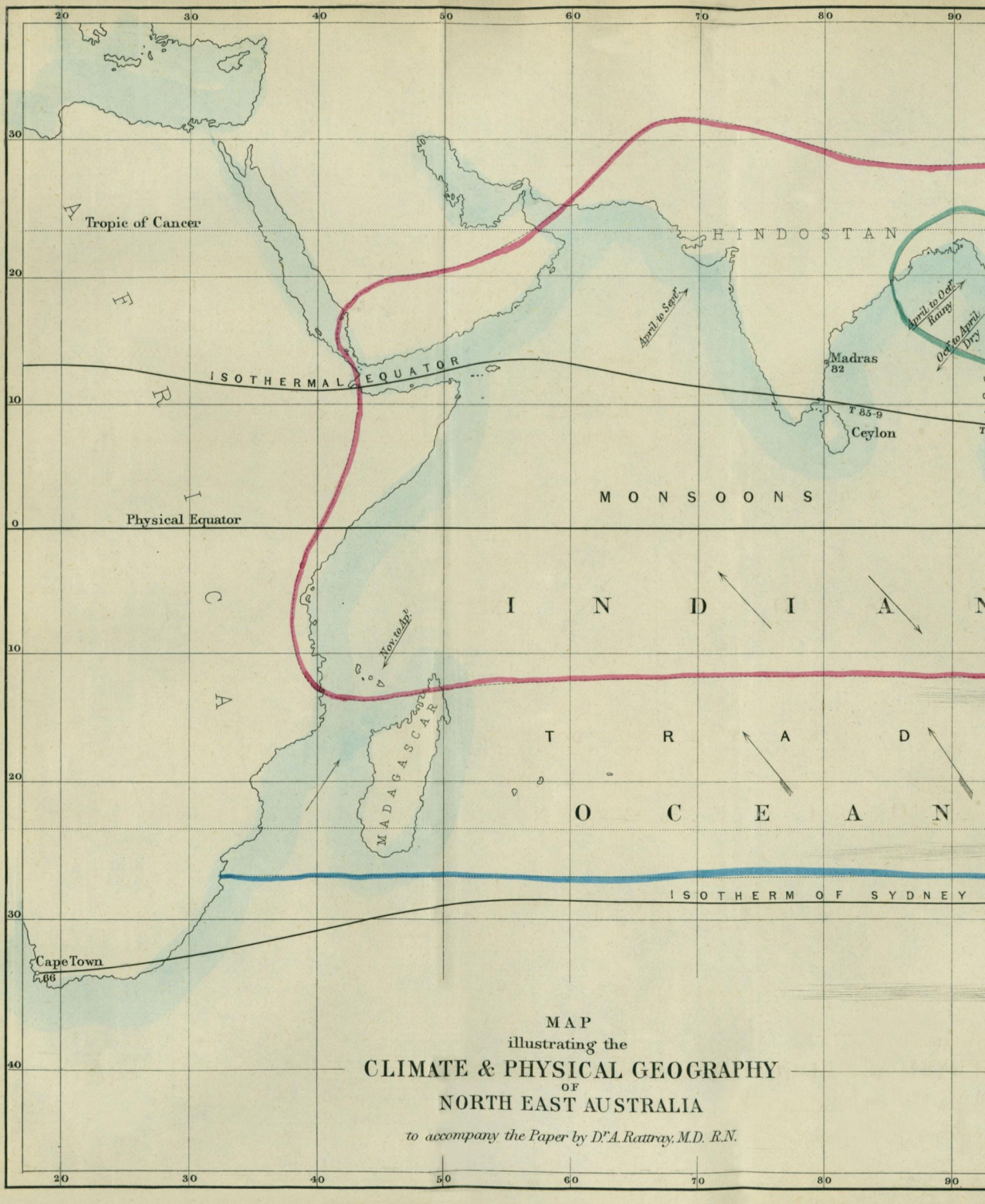
In the *wet* season the north-west is the prevailing wind, lasting usually for three months and a half, viz., during the latter half of November, December, January, and February. Blowing then both from the north and west, and sometimes from the south-west, the air is highly moisture-laden, accompanied by an overcast sky and heavy rains, the weather being oppressive and weakening. Rain falls most frequently with a south-west wind, the probable reason of which will presently appear. This monsoon is much less constant than the other, and occasionally alternates for a day or two, with breezes from the opposite quarter, especially at its commencement and decline. Its advent is often strong, squally, and accompanied by thunder and lightning, calms, fog, and a sultry clammy atmosphere; but its force, as a rule, is not so great as that of the other monsoon. As with the latter, the north-west varies in direction from south-west to north; while its beginning and close are by no means regular in their accession, but come sometimes earlier and occasionally later than usual.

In the *dry* season the south-east monsoon prevails, lasting usually from March to October, or November; marked by a more or less constant breeze having a general southerly and easterly direction; occasionally of force 7;* often lulling night and morning, but rising with the sun towards afternoon; moisture-laden and cool; sky usually clear and sunbright; showers very unfrequent. The coolest and finest months are July, August, and September, when the sun is furthest north. The greater part of this monsoon is wonderfully bracing and enjoyable in the shade, though hot in the sun, when the thermometer rises sometimes to 120° Fahr.; but less pleasant for a month or fortnight towards its commencement and close, when the weather becomes variable as the one monsoon merges into the other, and this loses while the incoming breeze gains force.

According to Macgillivray ('Voyage of *Rattlesnake*'), the natives of the vicinity of Cape York divide the year into three, viz., *Aibu*, or fine weather; *Kuki*, or wet weather; and the *Malgui*, or change. The latter, or transition from the dry to the wet monsoon, is marked by calms or light winds, sometimes from the west, and by gloomy unsettled weather, overcast sky, occasional showers, and frequent violent squalls of wind and rain. As the west and north-west winds gradually set in the weather moderates; rain becomes more frequent and heavy; the breeze steadies and alternates with the occasional lulls, calms, and fogs, already described as marking the rainy season when fairly set in. During the change from the wet to the dry monsoon also we usually have more or less unsettled weather, with squalls, and alternating north-west and south-east winds, that by-and-by merge into the steady south-east trades.

The nature of these periodic winds is evident. The belt of trade-winds would extend in a continuous circle round the globe if the equatorial ocean were uninterrupted by land. The latter, however, in certain regions acts as a disturbing influence and causes them to be turned back on themselves during a certain part of the year when the sun is over the land, the rapid and intense heating of which it is that causes the deflection. The limited monsoons of the Pacific coast of Mexico, and those of the Gulf of Guinea, are merely the trades of the northern hemisphere deflected; and those of the coast of Brazil, the trades of the southern hemisphere similarly acted on. But it is in the Indian Ocean where those periodic winds are most extensively developed. Here they exist over a huge quadrilateral, in which both the northern and southern trades are deflected—the conti-

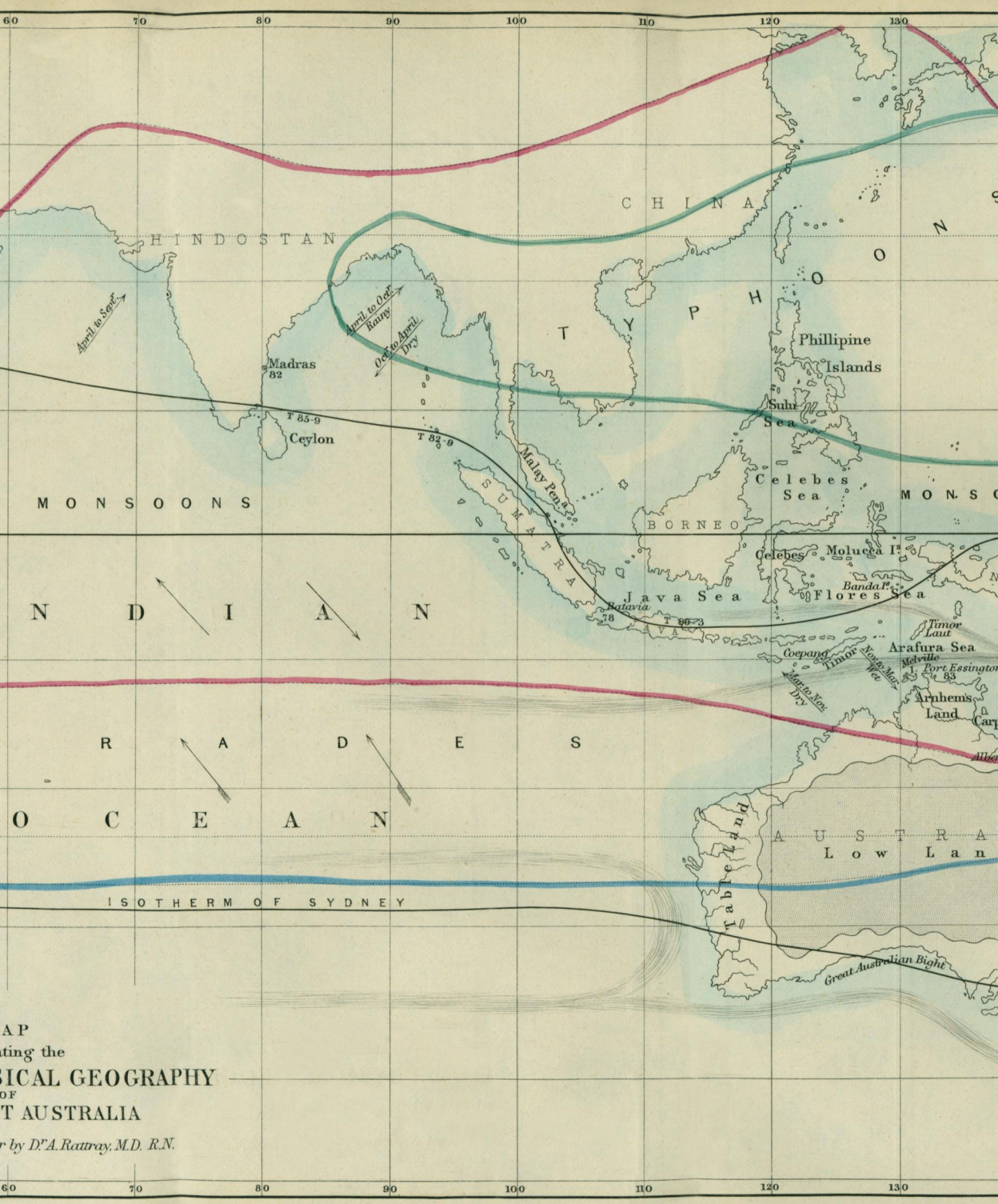
* Reckoned according to the ordinary sea scale, which ranges from 1 to 12: from 1 to 3 being a light wind, 5 to 7 fresh, 7 to 8 strong, and 10 to 12 violent.



MAP
illustrating the
CLIMATE & PHYSICAL GEOGRAPHY
OF
NORTH EAST AUSTRALIA

to accompany the Paper by Dr A. Rattray, M.D. R.N.

Published for the Journal of the Royal



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Published for the Journal of the Royal Geographical Society by J. Murray, Albemarle Street, London, 1868.

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nent of Asia forming the heating surface which acts on the northern trades and converts them into the monsoons of India and China; and Africa and Madagascar on the west, with North-Australia, New Guinea, &c., on the east, that cause the monsoons of the southern hemisphere. The winds of Northern-Australia and New Guinea form the south-east corner of this monsoon area. On either side of the equator, though of the same nature, the breezes necessarily blow, as the trades do, in different directions and with dissimilar force. Thus, while those of India are south-west and north-east, those of Northern-Australia are south-east and north-west. This is owing to the relative position which the land on either side bears to the central sea. Again, while the south-west monsoon of India prevails during the same months as the south-east of North-Australia, the former is a rainy wind and the latter dry. And further, while the opposite or north-east monsoon of India prevails during the north-west wind of Australia, the former constitutes the dry and the latter the moist or rainy season. Thus in either hemisphere it is the breeze which blows *from* the equator (*i. e.*, the centre of the Indian Ocean) to the north or to the south respectively, which is the rainy wind. The general limit of the monsoon region in the southern hemisphere is lat. 10° or 11° s. The heating influence of Madagascar, however, extends it at its south-west corner, while Australia and Papua carry it still further down towards the east, where it reaches to about 15° s. lat. From the limited area and smaller heating power possessed by the narrow Cape-York peninsula, aided by the cooling influence of the waters which bathe it on both sides, the monsoons do not extend quite so far south as in the more extensive tract further west, where they doubtless blow also with greater force, especially near the coast.

Again in the Indian Ocean, between Australia and Madagascar, where no land exists to make the monsoons pronounced, they blow both feebly and irregularly, their force increasing towards the land on either side, especially Australia. And we find it stated that "the parts where the north-west and south-east monsoons prevail with greatest strength and regularity are in the Java Sea, and from thence eastward to Timor, amongst the Molucca and Banda Islands, and on to New Guinea." This is only what theory would predict, and its correctness we can vouch for from a recent passage through these waters in H.M.S. *Salamander*. Blowing strongly as we passed through the funnel-shaped Torres Strait, the monsoon gradually lessened in force as we made westing in the Arafura Sea, till about the south point of Timor-laut; but thence along the south and east coasts of Timor, Sandalwood Island, the straits of Lombok, and Java Sea,

they blow even more decidedly and strongly than at Cape York itself; intensified, doubtless, by the indraught caused by the sun's heat on these extensive equatorial islands.

Lat. 15° s. is usually laid down as the southern limit of the Australian monsoons. The results of recent travel and settlement, however, tend to render it almost certain that they extend as far as 18° south; since they are found at the bottom of the Gulf of Carpentaria during the hot and wet months of summer. The monsoons of India and those of North-Australia are thus totally distinct, although they come in close contact at the equator—blowing, however, in opposite directions. It is the huge heating surfaces of Australia, and especially its dry parched interior, which is the cause of the north-west monsoons of this part of the globe. Were Australia removed there would be no monsoons in this region, and south-east trades would prevail throughout the year; while those of Asia in the northern hemisphere, and slight monsoons in the Mozambique, would alone remain of the present monsoon quadrilateral.

The south-east monsoons of North-Australia may be regarded as the regular trades, continuous and identical with those which girdle the southern tropic, though differing somewhat from them. The action of the sun's heat when in the northern hemisphere during June, July, August, and September, on the surface of Sumatra, Java, Borneo, and other large islands of the Eastern Archipelago, and especially New Guinea, only 90 miles from Cape York (and also on Northern Australia itself) causes an ascending current of warm air, which has to be replaced by colder and heavier air drawn from the south-eastern current; which, when superadded to, necessarily intensifies the force of the ordinary south-east trade of this region. Moreover, it is to the heating effect of the solar rays on these same land-surfaces during the advancing day that we are to ascribe the increasing force of the monsoon towards afternoon, when the effect of the Coral Sea (which keeps its heat better and cools more slowly than the land) comes into play; and though not sufficient to cause a counter-current seaward (south or south-east), is yet strong enough to exactly counterbalance the south-east trades of the day-time. Hence the morning, evening, and often nightly calms. Their cause is thus identical with what creates ordinary sea and land breezes; Papua and the northern part of the Cape York peninsula being the one agent and the Coral Sea the other. In proof of this we find that further south, as at Rockingham and Cleveland Bays (lat 18° and 19° s.), out of the monsoon but in the trade-wind region, the sea and land breezes are regularly established, and supersede the south-east trades night and morning, though not during the day; while at Somerset, during

the south-east monsoon, cold land-winds not unfrequently blow at night from the south-west, with a considerable reduction of temperature, and sometimes more pronounced local sea and land breezes. We know little of the meteorology of that part of tropical Australia which lies to the west of the Gulf of Carpentaria; but it is probable that the influence of the Coral Sea, weakened by distance, will not so much affect this monsoon or cause a similar daily increase and morning and evening lulls. In short, these peculiarities prevail only near the north-east coast, except it be that the wide Gulf of Carpentaria takes the place of the Coral Sea and influences the south-east trades in a similar though minor manner. But, on the other hand, the effect of the extensive land-surface in question on the south-east trade which blows over it will be to lessen its intensity during the day, and increase it at night. The heating land tends to counteract it by day, and rapidly cooling, to augment it by night. In brief, the south-east trades, which on the north-east coast are intensified by day, and just balanced night and morning, blow here less strongly during the day, and with greater force at night. Thus the south-east monsoon winds of Torres Strait are only the south-east trades, frequently intensified by day and lulled at night by local and easily explained causes; and those of North-west Australia the same wind decreased by day and augmented at night by readily-understood influences.

Along the south of New Guinea, and especially in its Gulf, *i. e.*, close to the motor power or land surface, the heating of which so augments the monsoons of the Torres Strait region, these winds are doubtless stronger than along the east coast of the Cape York peninsula. But on this we cannot speak definitely, for Papua presents so much in its geographical position, physical features, &c., that elsewhere materially influences and modifies climate, that its climatology, a fertile field for future enquiry, will doubtless be found to possess many peculiarities and anomalies to be elucidated only by more prolonged and accurate research than has yet been possible in the visits of two of H.M. surveying vessels only (*Fly* in 1842-6, and *Rattlesnake* in 1846-50), which did no more than survey the south-east coast, and never ventured to send expeditions inland.

Though termed the south-east monsoon because it blows principally from that part of the compass, this wind ranges over several points, and is often S., S.E., S.S.E., and so on; while another peculiarity consists in this, that within a certain distance (say 8 or 12 miles), and the same may be said of the trades further south, it takes more or less the general direction of the coast, which, however, as a whole, has itself a south-east

and north-west trend from Sandy Cape northward. We are to look for the cause of this in the mountain range that runs up the north-east coast of Australia comparatively close to the sea; which, though not very lofty, is sufficiently elevated to deflect the lowest, and hence densest, stratum of air, and cause it to follow the sinuosities of its bays and headlands. 200 or 300 miles from the coast the monsoons and trades are more direct and constant, being there uninfluenced either by sea and land breezes or by the contour of the land. By being thus turned aside we may partly account for another peculiarity in the monsoons of the Torres Strait region. Like the trades generally we might expect the south-east monsoon to blow most strongly near the equator, and hence at Torres Strait than further south. Still this will not altogether account for their force at Cape York, and we must look to the above-mentioned fact for a satisfactory explanation. Turned aside thus, the south-east monsoon follows the contour of the coast, getting stronger as we approach Torres Strait, through which its course is unopposed. The same wind, impinging on the coast of New Guinea, is doubtless similarly deflected westward by the lofty mountain range running through that island in a general east and west direction, but with a northward bend likely to promote this effect. Concentrated thus, the monsoons of the north-east coast of Australia and Gulf of Guinea find an outlet in Torres Strait, through which they rush in a westerly course; and so strongly do they blow, both here and along the coast to the north of Cape Melville during those months in which it is best developed, that H.M.S. *Salamander*, unable to steam against it and the strong tide, has on more than one occasion been compelled to anchor for several days until it lulled. This usually occurs during June, July, August, and beginning of September, when the heating power of the sun, then close to the equator, on the shallow seas between Asia and Australia, is greatest.

This deflection of the south-east monsoon, by the coast of north-east Australia, necessarily makes it less strongly felt in the region beyond; and, conjoined with other causes already spoken of, forms another reason for believing that in western tropical Australia they blow with less force, at least during the day, than near Cape York. We at least know, for certain, from the travels of Leichhardt and the Jardines, that both the south-east monsoon and trade are little felt in the comparatively level part of the Cape York peninsula which lies to the west of the main mountain range, and the Gulf of Carpentaria adjacent to it. Another reason why the south-east monsoon blows so strongly near Torres Strait will be given hereafter. Meanwhile

one effect of its concentration is to materially increase its humidity, which is often very observable at Somerset. Further south, along the coast, its moisture necessarily decreases, *pari passu*, with its lessening force.

The opposite or north-west monsoon may be termed a prolonged sea breeze, and regarded as the south-east monsoon deflected or turned back on itself by the influence of the land of Australia. When the sun is in the southern hemisphere, and right over this, especially its parched interior, the superheated air rises and creates a north-westerly current; which, coming from the equator, is warm, and from over the sea moist. This land surface however, much less extensive than that of the Asiatic continent, leads this monsoon, unlike the winds of India and China, to last no longer than 3 or $3\frac{1}{2}$ months, if so much; after which, when the sun again recedes, the influences which cause the opposite breeze come into play, and the more prolonged south-east wind is resumed. Though called the north-west monsoon its direction often varies. Rains often prevail then, for a reason to be presently explained. It is often irregular at Cape York and along the adjacent eastern coast, as south-east winds occasionally intervene and blow for days; while calms are frequent, doubtless because the heating power of the limited area of the taper point of the Cape York peninsula is often counterbalanced by the cooling influence of the extensive water-surface on either side of it, and the temperature of the air thus prevented from rising sufficiently high to cause an equable, strong, and permanent wind. The more extensive area of Arnhem's Land, to the west of the Gulf of Carpentaria, doubtless makes the north-west monsoon of that region both stronger, more regular, and more equable; and those occasional lulls and counter-currents unfrequent; while it probably comes earlier and lasts longer, as it will also in New Guinea, the extent of which land-surface, traversed by lofty mountains, will lengthen and render more regular this periodic wind in that region, and assimilate it to its analogue in India and China. Thus while the south-east monsoon is *regular*, the north-west is *irregular*. Moreover the warmth of the adjacent waters of the Gulf of Carpentaria, Arafura Sea, Gulf of New Guinea, and Coral Sea often act so as to modify and even occasionally counterbalance the north-west monsoon in a manner to be presently described. Thus it is probable that in the wide tract of country to the west of the Gulf of Carpentaria, both monsoons will be found on closer investigation to blow more regularly and equably, though perhaps with less strength, than at Cape York, where there are many and serious disturbing influences at work to

interfere with their constancy, force, and direction; while again the north-west monsoons are no doubt longer and the south-east winds shorter in duration, each occupying a portion of the year more akin to what prevails in India.

Here, as in other monsoon regions, major and minor differences may be observed in the two great divisions of the year. Thus the rainy season may commence sooner, be delayed, or show a greater or less rainfall. While again the south-east winds may be either strong or gentle, wholly dry, or varied by occasional showery or hazy weather. More or less important differences like these frequently occur, even in successive years: *e. g.*, during 1866-7 the wet monsoon did not fairly commence at Cape York till the end of February, and only lasted a fortnight, the rain however which fell then being great. And again, at the Adelaide River settlement, lately abandoned, the rainy season did not set in till the end of January, 1867, though the rain fell heavily, and one night to the extent of 5 inches. These irregularities are more apparent towards the verge of the monsoon region.

To accurately determine when the monsoons of the north-east coast of Australia change, is of interest not only in a scientific but in a mercantile point of view in connexion with the commerce carried on between these colonies and India, China, and England *viâ* Torres Strait, which is a shorter and in some respects easier and better track than either that to the east of New Caledonia or to the west of Australia, although it has one disadvantage, viz., that ships cannot make this passage during all parts of the year. The northward voyage can be easily accomplished by sailing vessels only during the south-east monsoon, and the southward trip only during the prevalence of the more fitful north-west wind. At other periods the passage either way is apt to be tedious. It is therefore a matter of importance to lay down with precision the time of change of the monsoons, so that vessels going either up or down may not be disappointed in the wished-for winds. Unfortunately, however, little that is trustworthy has since been added to the information so diligently collected by MacGillivray, and published, some fifteen years ago, in the 'Voyage of the *Rattlesnake*.'

In endeavouring to define and classify the various influences which more or less affect the prevalent winds of Cape York and its vicinity, it must be remembered that the climate of any locality is often materially modified by that of surrounding districts; and that this forms the centre of a wide area, of the climate, &c., of which we as yet know very little, and in many respects nothing at all. The western half of Papua, for example, only 90 miles from Cape York and almost visible on passing

through Torres Strait, has never yet been visited by any traveller to define its climate and meteorology, or otherwise add to our scientific knowledge. While of the climate of the Gulf of Carpentaria and Northern Australia beyond, we have as yet only fragmentary, imperfect, and, with one or two exceptions, unscientific accounts made by settlers, and hence of doubtful value. When we know more of this wide and yet unexplored region, it is probable that other agencies than those here subjoined will be found to operate on and modify the prevailing winds and climatology of Cape York.

1st. The hilly range which traverses the whole length of the Cape York peninsula deflects the south-east trades and monsoons, causing them to follow the contour of the coast, and thus vary with every headland and bay, although they still preserve a general south-easterly direction; and further tends to intensify them as they near the funnel-like opening of Torres Strait. The same obstruction, moreover, prevents these winds from being much felt in the region beyond, and at the same time acts as a sponge by abstracting their moisture and precipitating it as dew or rain on the eastern slope; a fact which partly accounts for the parched character of the country to the westward.

2nd. It is to the opposed and alternately ascendant heat of the Cape York peninsula, and perhaps Papua, on the one hand —and of the seas which bathe the former on its east and west coasts on the other—to which we are to ascribe those lulls and calms which occur in both monsoons, the occasional reversal of the breeze during the north-west monsoon, and the frequently increasing strength of the south-west wind during the afternoon. Further south, in the trade-wind region, the sea and land breezes are regularly established.

3rd. Blowing from a long distance over the Southern Ocean and Coral Sea, the south-east monsoons are both moisture and ozone-laden, and rust iron even more readily than the wet north-west winds. Again, the north-west monsoons, blowing from the warm equatorial Indian archipelago, largely composed of shallow and hence highly heated inter-insular seas, are sufficiently moisture-laden and warm to precipitate the heavy rains which then prevail. So also the south-west winds, coming from the super-heated surface of the Gulf of Carpentaria during the wet monsoon, are rainy and are the winds with which rain is most frequently associated in this region.

4th. Like the trade-winds elsewhere, the south-east monsoon or exaggerated trades of this region take a more westerly course as they approach the equator: and as the trend of North-Eastern Australia takes more and more the same direction as

we go north, this wind thus follows the coast outline: an effect aided as above-mentioned by the mountain-range.

5th. That the physical geography of Torres Strait and its vicinity, and especially the shallow neighbouring waters, have a material influence on climate, temperature, and particularly the prevalent winds, which become modified in force, direction, and character, is not a mere supposition but an opinion based on facts. This narrow passage acts as a funnel for the concentration of westerly currents both of warm water and heated air. Here it must be remembered we are not only in the tropics, but within 9° of the thermal equator; and the following table will show how much the temperature of the sea in any region—say at the equator—is above that of higher latitudes; and how rapidly it rises as we near the torrid zone. The higher temperature for the same parallel, in the southern hemisphere, will be apparent. Heated principally by radiation, the warmth of the air necessarily rises with that of the sea.

TABLE to show the TEMPERATURE of the SEA (surface) and AIR, according to Latitude. (DAYMAN—Voyage of *Rattlesnake*.)

Latitude North.	Sea.	Air.
°	°	°
23	69	68
21	71	66
18	73	68
15	73	72
8	82	78
6	84	82
5¾	82	79
5	83	82
Equator.		
1	83	77
2½	80	79
5	80	78
7	80	79
12	81	79
15	80	79
17	81	80
20	80	78
26	67	76

These observations were made in the Atlantic; but the same law prevails in the Pacific, and in Torres Strait itself, and is indeed universal, and the true cause of the trade-winds and monsoons. This will be evident from the following observations which give the temperature of the sea and air for similar latitudes (lat. 11° s.) in the same (south) hemisphere in the Atlantic, middle of the Pacific, and Torres Strait, about the same period of the year (March). Observations for the same

year would be more satisfactory; but it would obviously be difficult, and for one observer impossible, to obtain this :—

S. Atlantic (Lat. 11° s.) 1864. H.M.S. *Salamander.* Temperature of Air.	Sea.	S. Pacific (Lat. 11° s.) 1860. H.M.S. *Topaze.* Temperature of Air.	Sea.	Torres Strait (Lat. 11° s.) 1867. H.M.S. *Salamander.* Temperature of Air.	Sea.
80½°	80½°	74°	73°	78½°	81½°
78½	79½	74½	73½	82½	82½
78½	78¾	74	74¾	81½	81
77½	78½	76	75½	84	83½
Highest observed Temperature of Sea in S. Atlantic.		Highest observed Temperature of Sea in S. Pacific.		Highest observed Temperature of Sea in Torres Strait.	
83° Fahr.		83° Fahr.		84° Fahr.	

These observations were made at noon; and show, first, how high the temperature of the sea and air at Cape York is, when contrasted with that of the middle of the same ocean (Pacific) of which it is an outlet, and that of the more distant Atlantic; and second, how much higher the warmth of the sea is above that of the air at Cape York, contrasted with what occurs in the middle of the two oceans, where we find comparatively little difference in temperature. The whole proves how warm the water at Cape York sometimes is at this particular season, as contrasted with that of the same latitude elsewhere; from which we may reasonably conclude that it is so as a rule during the entire year. These facts also go far to lead us to believe that, like the aërial, so the aqueous thermal equator reaches far south in this region, and probably passes through Torres Strait. For the cause of this we are to look to the shallowness of the water; and if we extend our survey we shall find that it is to the comparatively trivial depth of the seas in and about the Indian archipelago that the remarkable southward bend of the aërial equator in this region is due; for we must recollect that the air which overlies sea or land is not heated directly but indirectly, and by radiation; and that the temperature of either the land or sea respectively does not depend on that of the air, but the latter on the former. The following experiment, made in Torres Strait, will show that shallow heats more rapidly and intensely than deep water:—

Albany Pass (Coal Bay), 8th March, 1867, 2 p.m. Temperature of air in shade, 82° Fahr.; force of wind, 4°; of tide, 3 knots; a good swell on.

Distance from Shore.	Depth of Water.	Temperature of the Sea.
200 yards.	54 feet.	82½° Fahr.
30 feet.	9 „	83° „
20 „	4 „	84° „
10 „	1 foot.	84½° „
5 „	½ „	84¾° „

Thus the temperature of the surface-water, 200 yards from the shore, in a strongish wind and tide and good sea, when the temperature of the air was 82° Fahr., was 82½° Fahr.; whereas 30 yards from the shore of a bay in which she was anchored, exposed to the wind and an ebb-tide, it was ½° more (83° Fahr.) in a depth of 9 feet; 20 feet from the shore, at a depth of 4 feet, it was 84° Fahr.; 10 feet from the shore, at a foot depth, it was 84½° Fahr.; and 5 feet from the shore, at half a foot depth, it was as much as 84¾° Fahr., *i.e.* 2¼° Fahr. above what it was in mid-channel.

Thus the difference between the temperature of surface-water in 9 fathoms, and that of half a foot in depth, was no less than 2¼° Fahr. The influence of the shallowness of the water on its temperature would have been more marked, had there been less tide and wind to agitate the sea, and thus diffuse its surface-warmth rapidly; and also had the shallow part been more extensive; for here the sandy beach shoaled rapidly. More favourable conditions usually prevail in and near the numerous coral-reefs, shoals, and lagoons of this region; and especially the latter, in which the water often varies from a few inches to one or two feet in depth, and is but seldom and little influenced either by waves or tides to disseminate its surface-heat, or by winds to abstract it. Here the influence of the sun on the sea is more fully effected, and the result is water almost at a blood-heat, with a temperature closely approaching that of the still more highly warmed land. But to this we must still add another source of caloric in the numerous sandy patches, coral-reefs, and islands which bestud this strait and its vicinity, which necessarily contribute materially to raise the temperature. The effect of the sun's rays on these numerous islets and the shallow waters which encircle them is to raise the temperature of the air overhead, above that of neighbouring seas. Hence, as water is more retentive of heat than land the temperature of this region is doubtless often, especially at night, above that of the adjacent land; and thus when well warmed, especially when the sun is perpendicular, we can readily perceive that the effect will often be to cause an influx of air from adjacent regions, and bring surface-currents from over neighbouring lands or seas. As we shall presently see, this is what actually occurs. So great is the effect of these shallow waters on the air that we doubt much if the average annual temperature at Torres Strait, and a little to the east of it, is not greater than that of the land on either side—in Papua to the north, and the Cape York peninsula to the south. It is to the influence of this shallow region that we are doubtless largely indebted, with the effect of the Australian and Papuan surfaces, for the great

southward bend of the thermal equator in this quarter of the globe.

These remarks will render it evident that the shallow waters of Torres Strait and the adjacent coral-reef regions, heated partly by bathing warmer land-surfaces and partly from its mere shallowness, has a material influence both on the winds and temperature. Much of this region is no more than from 6 to 10 fathoms; but even in its deeper parts, the 15 or 20 fathoms form a marked contrast to the 35 of the Gulf of Carpentaria and Arafura Sea, the 30 and 40 common in the Java, Flores, Celebes, and other adjacent seas, the 150 to 300 of the neighbouring Coral Sea within 50 miles of Cape York, or the far deeper waters of the Indian and Pacific Oceans, seldom less than 1000 fathoms, and usually far more. Now let us conceive the effect of the sun on the reefs, islands, and shallow waters of Torres Strait. As in the above experiment in Albany Pass, we can readily perceive how water heated even no more than 2° Fahr. above that of the neighbouring seas, and probably it is often more, should cause an indraught to replace the heated air which rises overhead. This will partly explain the increasing force of the south-east monsoon during the afternoon when the sun is high, and this region most warmed. Hence also partly why these winds increase in force as we near Cape York: we are approaching this superheated region. And again it is greatly owing to this furnace-action during the summer season, when the sun is overhead and strongest, that we are to ascribe the frequent diversion of the north-west monsoons to a south-westerly course. The latter, which are the rainy winds of Cape York, are originally the north-west monsoons. On reaching the Gulf of Carpentaria, where they become if possible more moisture-laden, they begin to be deflected towards the warmer regions of Torres Strait, and take a south-westerly direction. We must not forget that at this season the sun is in the southern hemisphere and overhead or nearly so, *i.e.* directly over Torres Strait as well as over the entire length of Rossel's current which feeds it, and which is thus highly heated long before it reaches Cape York, where it at length arrives to become an important storehouse of heat and moisture. Were it not for the disturbing influence of these shallow waters, the rainy north-west monsoons would blow over, water, and fertilise the western part of the Cape York peninsula. As it is they are turned aside, and hence the parched barren character of this district, where neither monsoon blows with its full force; as the moist north-west wind seldom reaches it, and what of the south-east breeze it receives over the mountain-range is previously deprived of its moisture. Hence the atmo-

sphere is dry and parched, the vegetation suited only for arid districts (tea-tree, spinifex, &c.); the winds irregular, and often light; and is the reason why both this and the adjacent part of the gulf are often visited by violent squalls and thunderstorms.

Thus, in the chain of islands which connects Asia with Australia and the dry parched interior of the latter, on the one hand—and in the shallow seas which intervene, on the other—we have a double influence which materially affects the climate of this region. The warming of these islands and continental surfaces by the sea raises their heat to a maximum; while the inter-insular waters, which probably rise to a higher temperature here than in any other part of the ocean, serve to preserve their warmth. Hence why the average annual temperature of this region as a whole is so great, and why the thermal equator passes through it, and here reaches a higher latitude than in any other part of the southern hemisphere. Somerset and the Torres Strait district would share the same exalted temperature were they not acted on by other influences which lower it.

It is moreover to the varying shallowness of different parts of these seas, and the relation which this has to the size, contour, and general physical geography of adjacent land-surfaces that we are to look for an explanation of the differences of temperature and the modifications of winds and other peculiarities in the climate of different parts of this extensive region. The waters of Torres Strait are doubtless shallower than those of any part of the Indian archipelago. The influence which this has on the winds and climate of Cape York is very apparent; and similar phenomena will probably be found to prevail in many other parts of the Indian archipelago.

6th. Consisting of the south-east trades reversed by the heat generated by the massive island-continent of Australia, this north-west wind about Cape York is neither so regular, strong, nor prolonged as it doubtless is further west; and for this reason, that the peninsula—pointed, narrow, isolated, and moreover bathed by the sea on either side—is never heated so highly as the larger portion of Inter-tropical Australia to the westward of the gulf, which has no such adverse influences to counteract the sun's rays; and hence the counter-current or north-west monsoon is brief, feebler, and more irregular, seldom lasting over two and a half or three months; and also why, during the monsoon, the winds and rain are often replaced for hours and even days together by dry breezes from the opposite quarter, and why the north-west is an irregular monsoon, the period of its accession, duration, and decline being very uncertain. The Gulf of Carpentaria is thus an influence which disturbs the north-west monsoon. Had the former not existed, and the land from

Cape York to Cape Arnhem been continuous, this periodic wind would have been more regular and pronounced than it is, especially at Cape York.

7th. That Papua, only 90 miles from Cape York, with a great and almost continental area, and lying within a few degrees of the equator, does influence materially the climate and, especially, the winds of this region, cannot be doubted. It is to the heating of this vast mass of land, in conjunction with that of Australia, that we owe the monsoons of this region. It is to the sun's influence on it during the day when the south-east monsoon prevails, that we partly owe their increasing force, especially in the afternoon, as we approach Cape York. While, again, to its lofty mountains and the physical conformation of the converging coasts of New Guinea and North Australia, are we partly indebted for the westerly deflection and increased force with which the pent-up south-east monsoons blow through Torres Strait till they again spread out and become feebler in the Arafura Sea beyond. Nor can we doubt that the effect of the heated lofty land of the east end of Papua is to cause a land-wind, the direction of which would obviously be south-east. This will be strongest and most lasting when the sun is in the southern hemisphere, *i.e.* during the prevalence of the north-west monsoons. Is not this influence, superadded to others already mentioned, the cause of the south-west rainy winds of Torres Strait during this monsoon? The effect of sea and land breezes in modifying the monsoons of the Indian archipelago is thus, though not so marked here as off the south-east coast of Timor and in the Java Sea (Maury), at least very decided; and if Jansen's opinion as quoted by Maury be true—viz., that the north-west monsoons of North Australia are the north-east trades deflected, the cause of this being, of course, the heat of the land—we have here in these south-east winds occasionally prevalent at Cape York a second deflection, again induced, partly at least, by large masses of land, though principally by the furnace-action of the warm waters of Torres Strait. Much of this, however, is necessarily conjectural until we can obtain results from personal observation of the climate and meteorology both of the coast and interior of that land of mystery—Papua.

The climate of that portion of inter-tropical Australia, which lies to the south of the monsoon but in the trade wind region, is still little known, except along the east coast, where we find sea and land breezes prevalent night and morning, in addition to the south-east current of the daytime. It is only over the open ocean that the trades blow uninterruptedly; and in the interior, a district not yet fully explored, they are doubtless much modified, if not altogether abrogated by local causes, to be

elucidated by future investigation. For example, at the Albert River, instead of *moist* south-east trades, *dry* south-west winds, coming from the interior, are frequent. For various reasons already alluded to, the climate of the western Cape York district and the adjoining part of the Gulf of Carpentaria, is one peculiar to itself, differing widely from that of Somerset and neighbouring regions. Cyclones do not often occur in the monsoon region, but small ones occasionally blow with considerable violence further down the north-east coast in the latitude of the trade winds, and at least as far north as the Endeavour River.

Thus, as elsewhere, many influences combine to form and modify the prevailing winds of Cape York and the north coast of Australia. Confining our attention briefly to the special meteorology of this district, it appears unnecessary to load these pages with statistics of barometric, hygrometric, thermometric, electric, and other variations of the different seasons. Still, as mere verbal statements are valueless in one sense, and as bare platitudes without proofs, though not quite worthless, are yet liable to be received with a certain amount of doubt, we shall endeavour to follow a medium course, and advance no fact without some evidence of its scientific accuracy.

Dividing, then, the year into two, according to the monsoons, we find that the temperature from the beginning of March to the end of October, which constitutes the cool and dry season, varies at Somerset from about 61° or 62° Fahr., to 85° Fahr. in the shade. The pleasant and often strong south-east monsoon blows right up the Albany Pass, which has the same trend, and thus keeps the atmosphere of the anchorage and of Somerset itself pleasantly cool and wonderfully enjoyable for a tropical climate. In an expedition, made by Captain Carnegie (Sept., 1865), near the close of a very dry season, from Somerset across the narrow point of the peninsula to the shores of the Gulf of Carpentaria, the temperature was never over 85° (shade), proving the influence of the adjacent waters on both sides in equalising the temperature of the land. During the wet north-west monsoon, the temperature ranges from 75° to 90° (shade), but from the excessive humidity of the air the weather is then much more oppressive than with the south-east winds. During 1866 the highest thermometer in the shade was 90° Fahr., and the lowest 62° Fahr., thus giving an annual range of 28° Fahr.; while the average annual temperature was 78° Fahr. The daily and monthly thermometric variations are neither sudden nor great. The highest daily range of heat (12½ Fahr.) observed in the register of H.M.S. *Salamander*, occurred during August (dry season), and the lowest (9½° Fahr.) during January (wet season). The greatest monthly range observed was 14½ Fahr. The hottest

months are thus those of the wet season, particularly December and January, and the coolest those of the dry monsoon, especially August and September. The annual range for 1866, viz., 28° Fahr., is small, since 25° or 30° Fahr. is by no means an uncommon daily range at Brisbane, situated in the temperate zone (lat. 27½° s.). The average annual temperature of Port Essington, as given in Johnstone's 'Physical Atlas,' is 83° Fahr., which is 5° or 6° above that of Somerset; and the reasons are obvious. For one, Cape York is bathed on both sides by the sea, which keeps its temperature low, and prevents it from rising so high as if it had a wider extent of back country. Another reason is, that Somerset is more exposed to the cooling influence of the south-east monsoons, and less subjected than Port Essington to the warming effect of the north-west winds.

The limited annual thermometric range agrees with the law which finds that of low less than that of high latitudes, and, moreover, shows that the climate of the pointed northern extremity of the Cape York Peninsula partakes more of the littoral than of the insular or continental character. This will be evident from the following contrast with that of other and not too distant tropical places:—

ANNUAL RANGE OF TEMPERATURE.

		Latitude.	Range of Temperature.
LITTORAL	Madras	23° N.	34° Fahr.
	Callao	12 s.	22 „
	Bankok	13⅔ N.	13 „
	Somerset	10½ s.	28 „
INSULAR	Trincomalee	8½ N.	17 „
	Colombo	7 N.	10 „
	Guadaloupe	16 N.	19 „
	Barbadoes	13 N.	12 „
	Manilla	14½ N.	12 „
	Amboyna	3½ s.	10 „

Again, both the annual range of temperature for Somerset, the only part of inter-tropical Australia the meteorology of which has yet been studied (viz., 28° Fahr.), and also that of Sydney, in extra-tropical Australia (viz., 61° Fahr. in 1859, and 62° Fahr. in 1860), confirm the law that the range of temperature here, as in the southern hemisphere generally, is not so high as in corresponding latitudes in the northern half of the globe. Here, for example, we never meet with an annual range like that of Canada (138° Fahr.), or of Pekin (115° Fahr.), and for obvious reasons. We have not similar extensive tracts of land like those of Asia, Europe, North America, to cause these great reductions of temperature in winter, and high thermometer in summer; or those icy currents of water coming direct

from the poles, or warm ones from the equator, to cool or heat the land and superincumbent air; the one to increase the summer heat, and the other to augment the winter's cold.

Although the general warmth of the southern hemisphere is higher than that of the northern as a rule, a contrast of the average annual temperature of Somerset with that of places in about the same latitude on the other side of the equator, will prove that this general law is not carried out here. In this respect it resembles Callao, situated in about the same parallel on the opposite shore of the Pacific, whose climate, superior on the whole to that of Somerset, inasmuch as it has no rainy season, is wonderfully cool for a place so near to the equator. Thus we find from the following table that it is less by 4° Fahr. than that of Madras; by 6° Fahr. than that of Kouka, in the interior of Africa; and by 7° than that of Maracaybo in South America; all three situated about the same distance from the equator, but in the opposite hemisphere; and whose temperature therefore it ought, reasoning from the above law, to have exceeded.

	Fahr.	
Somerset, average temperature 1866 ..	78°	
Madras „ „ ..	82°	Johnstone's Physical Atlas.
Kouka „ „ ..	84°	
Maracaybo „ „ ..	85°	

The solution of this apparent anomaly is to be found in the proximity of Somerset to large sheets of water, which both equalise and lower its temperature. The same cause keeps the annual range of temperature at Cape York so much lower than at other places along the coast of New South Wales, *e. g.* Sydney, where it is often more than 60° Fahr.

We may now give a contrast of the annual average temperature of Somerset with that of places situated about the same distance on the south side of the equator.

	Latitude.	Fahr.
Benguela	$12\frac{1}{2}°$ s.	77°
Bahia	12° 57′ s.	78°
Callao	12° s.	73°
Somerset	$10\frac{1}{2}°$ s.	78°

Somerset is thus surpassed in the comparative lowness of its average annual temperature only by Benguela and Callao, which is to be accounted for by the former being in a somewhat higher latitude, and the latter by the same reason, added to others still stronger, viz., its proximity (50 or 60 miles) to the base of the Andes, from whence cold winds occasionally blow down to lower its temperature; and, above all, the influence of the cold antarctic coast-current which washes the adjacent shore.

In ordinary circumstances the rise and fall of the barometer at Somerset is comparatively slight, as in the tropics generally, the annual range being seldom more than 0·50 or half an inch. Before squalls and cyclones, however, it sometimes falls considerably; but this does not usually last long. During the dry south-east monsoon from 29·80 to 30·20 may be given as the range, and 30·10 as the average. During the rainy season its range is from 30·00 to 29·70, the average being about 29·85 or 29·90. Thus, during the *dry* months, it is seldom *below*, and during the *wet* season seldom above 30·00.

The hygrometer (Mason's) shows that the atmosphere of Somerset is driest during August and September, when the greatest difference between the wet and dry bulbs is 9 or 10, and the average, 4, 5, or 6. The same prevails along the tropical part of this coast in this the summer season. During the heavy rains occasional calms, squalls, and frequent mists of the rainy season, the hygrometer indicates an uncomfortably moist atmosphere; a fact further rendered evident by the perspiration, which constantly exudes, and renders the skin clammy, the saturated atmosphere preventing evaporation. The difference between the wet and dry bulbs, then, is usually from 1° to 1½° or 2°; and very rarely, and only for brief periods, 4° or 5°; and this prevails, not only here, but as far down the coast as Cape Capricorn.

The rainfall varies considerably in different years, both in the regular rainy and the so-called dry season. In the latter showers are usually unfrequent, slight, and brief. During the north-west or rainy monsoon heavy and prolonged rains are common, sometimes with high winds, but not unfrequently with calms. Occasionally (as in 1866-7) the yearly rainfall is comparatively slight for a tropical region, and the north-west monsoon brief; the sky is clear and less clouded, and the air less damp. Thus in this monsoon region, as in the trade wind zone further south, as well as in Queensland and New South Wales, the length and characteristics of the seasons are very uncertain. Several wet ones, welcome, unless too moist, to the farmer of Eastern Australia, may be followed by one of intense and lasting drought, causing great loss by parching the land, destroying the grass and other crops, and starving thousands of sheep and cattle by the deficient water and pasture supply. At Somerset, during the year 1866, the annual rainfall was 103 inches; during the previous, and also during the past year (1867) very much less. Further south, along the coast in the trade wind region, although the rains do not partake of the monsoon character, either as to intensity or duration, they agree in being most copious during summer, when the sun is

to the south of the equator. They differ, however, from the monsoon rains in being by no means unfrequent, though less copious, during the summer, when occasional showers occur, usually attracted by the mountain range which skirts this coast. Still further south, beyond the tropics, the rains, as in all temperate climes, are irregular, and occur both during summer and winter; although, as in other temperate latitudes, by far the most copious and prolonged during the latter. Thus, as the summer is essentially the rainy season in the tropics, both in the trade-wind and monsoon regions, so is the winter in extra-tropical regions. Although a hazy horizon in the south-east is not uncommon during the prevalence of the dry monsoon, indicating a highly moisture-laden ocean air, fogs and mists are very rare in this comparatively rainless season. During the fortnight or month which precedes and follows it, ushering in and out the opposite monsoon, they become more common, and during the wet season itself very frequent, though more so in some years than in others, and then they usually prevail during the calm intervals between the heavy rains of these months.

No systematic series of observations has yet been made as to the electric conditions of the atmosphere of this region. During the wet season, thunder and lightning are common, and often accompanied by squalls and heavy rain. The electric explosions are seldom near the earth, however, but usually distant, and dully heard high overhead through the dense masses of cumuli and nimbi, and are thus seldom attended with such danger to life and property as in New South Wales and Queensland, where their altitude is often less, and deaths from lightning by no means rare.

Observations with regard to the subtle gas, ozone, nature's chief disinfectant and deodorizer, her principal antidote to and preventive of many infectious and miasmatic diseases, and now regarded by some as a potent instrument both in the production and cure of disease, were made by Lowe's test paper. At Somerset, during the prevalence of the north-west or rainy monsoon, the average discolouration was from 1 to 3 only. On one occasion it rose to 7, and once to 12, with a temporary south-east wind. Ozone was not unfrequently absent, especially during calms. During the opposite or dry season (south-east winds) the average was 3, and the highest 9. Ozone was very seldom entirely absent, and then usually during calms. It marked highest during S.E. and E.S.E. winds, chiefly when the air was very damp and hazy, or after showers. Along the coast between 14° and 25° south latitude, including all between the southern limit of the monsoon and Brisbane, the quantity of ozone with westerly and north-westerly (both dry) winds was small; but with east

and south-easterly breezes, especially if much rain fell, it usually rose, and sometimes reached 11 or 12. At Moreton Bay (south latitude 33°) the quantity during calms and light winds was little, and often none. With westerly (dry) winds rather more; but with sea breezes, and hence a moist atmosphere, *e.g.* E., S.E., S.S.E., S., and N.E., &c., it was abundant, especially when the hygrometer indicated saturation. With heavy rains it was abundant, viz., 8 to 10, even in the absence of thunder and lightning; and occasionally it rose to 12 with a southerly (ocean) wind following a thunder, lightning, and rain storm from the west. At Sydney little is found with calms or north-west and west (*i. e.* dry or land) winds; but in calms, with an overcast sky and damp air preceding rain it is often considerable; but most prevalent with east and south-east (*i. e.* moist) winds, and less abundantly with west (*i. e.* dry) breezes. During very heavy squalls from the east (*i. e.* the ocean), with rain, it sometimes rises to 12; and during north-easterly winds with a damp atmosphere to 15.

From these facts we may therefore draw the following deductions:—

1st. That along the coast of Australia the quantity of ozone is more influenced by the direction, source, and velocity of the wind than by the humidity of the atmosphere or its electric state.

2nd. That both in the monsoon and trade wind regions of this coast (*i.e.* the tropics), and in the latitude of variable winds (extra-tropical), it is found in greatest abundance during certain winds, and least copiously in others.

3rd. That those which blow most directly from the ocean are the ozone-bearing winds, while such as come from a landward source are least impregnated.

4th. That its amount in the ozoniferous winds is affected by moisture, and is greatest when the air is most highly saturated, and especially when rain falls.

5th. That the rainfall taken alone, has little, if any, influence on the quantity of ozone in the air. If it had the latter would not prevail most during the south-east or dry wind.

6th. That although ozone is least abundant at Cape York during the north-west monsoon or rainy season, when thunder and lightning are frequent, and most evident during the opposite or dry south-east winds, when these seldom occur, we must not conclude that the electric state of the air has no influence on its formation and quantity. For the electric explosions of the former season usually occur high overhead, and seldom in the lower strata of air, which are apparently little affected; whereas the ozone-bearing south-east winds come from higher

latitudes, especially the verge of the tropics, where electric explosions are also very common in Australia, particularly during winter (May, June, July), near the surface; a fact previously alluded to. Observations on the electric condition of the atmosphere at Somerset during the two different periods, and for the region about 23½° s. lat., would determine this.

7th. That about Brisbane it is present in greatest abundance during thunderstorms, with rain coming from seaward, which makes it appear as if both moisture and electricity took part in its production, the ocean surface, where the air is both most humid and most highly electric, being doubtless its source; the latter being the agent which causes and favours its generation: and that moisture, either in the shape of rain, fog, or mist, are agencies which attract, perhaps concentrate, and certainly carry it along as they do the electric fluid itself.

8th, That, for reasons already mentioned, the great abundance of ozone at Cape York during the south-east monsoon, when rain, thunder, and lightning are unfrequent, and its smaller quantity during winds and rain coming from sub-equatorial and apparently more highly electric regions, and, on the other hand, its greater abundance further south during winds from seaward than from landward, tend rather to prove that ozone is than that it is not electrified oxygen, but some other compound of the latter gas.

9th. That though its unquestionable oceanic frequency might lead us to infer that ozone may be a compound of aërial oxygen with some gas derived from the sea, *e. g.*, chlorine, these phenomena are equally explicable on the supposition that it is an oxydated form of oxygen, the formation of which may be going on at all times over and close to the ocean, cotemporaneously with evaporation, though materially aided by certain conditions, and especially accelerated by electric commotions: while calm weather retards its formation by lessening the evolution of moisture; high winds and rough water having, for an obvious reason, an opposite effect.

The characteristic aspects of the wet and dry seasons at Somerset are widely different; nor is this more marked in the inanimate world than in the animal and vegetable kingdoms. As in the tropics generally, there is no real winter; and throughout the year perpetual summer seems to smile. Even in the cool south-east monsoon, which is the normal winter, gaily painted flowers and gaudy insects are by no means rare; for nature never sleeps in warm as in cold climes; and the great difference between the two seasons consists mainly in the profusion of animal life and exuberant vegetation which characterise the *wet*, and the paucity of the one and semi-dormant, or

rather parched state, of the other, which mark the dry. Hence we never witness here the gradual development of the seasons; spring slowly expanding into summer; that again merging into autumn, to be in turn followed by winter; as we have in temperate latitudes where the sun is the revivifying agent, while here it is the rain. And as in the one, nature is reanimated slowly by the gradually increasing intensity of the solar rays, and months are occupied in the process; in the other, she springs into life and asserts her genial sway with such incredible celerity, that nothing can be more wonderful than the difference noticeable, even a few days after the advent of the north-west monsoon, with its profuse and invigorating rains. Grasses, ferns, bulbs, &c., soon shoot forth and grow with amazing rapidity, buds sprout, and flowers bloom, till soon the whole country, profusely covered with vegetation, and clad in a gorgeous robe of bright green, variegated with gay flowers, assumes more the aspect of a tropical land than during the more lengthy dry south-east monsoon, and yields a strong contrast to its late parched cheerless character. In this change the animal kingdom participates. From every crevice in the perforated ironstone rock, every hole burrowed in the hard stony soil, scorpions and lizards come forth, snakes, *e. g.* the carpet snake, often 12 feet long, and the rarer but venemous black or brown snake; while occasionally the huge gavial, 20 or 25 feet long, tempted from the not far distant muddy and mangrove-fringed bays which lie towards Cape York, shows its serrated back as it floats lazily with the tide through the adjacent Albany pass; or the ungainly sun-fish, as it swims along with the peculiar fan-like motion of its dorsal and ventral fins. Insect life, rare in the dry season, now teems. Butterflies of many fine varieties flaunt their gaudy forms. Ants, both winged and wingless, beetles, scolopendræ, &c., abound on every bush and tree, and hide beneath each stone. The air is alive with the hum of the native bee, the chirp of the cricket, and the song or cries of pairing birds, among which we may notice the black cockatoo, the common yellow-crested white cockatoo, the parraqueet, the rare and beautifully plumaged rifle-bird (*Ptilorus magnifica*), a pretty migratory wood-kingfisher (*Tanysiptera silvia*), and the laughing jackass, of wider distribution; while the mosquito and several varieties of the common house fly often become a household pest. Soon after the cessation of the rain, however, the gay flowers wither, and with them insect life rapidly disappears. The Lacertæ and Ophidiæ return to their subterranean haunts to hybernate; the few migratory birds which annually visit Cape York from New Guinea and the intervening islands are no longer seen, the ground becomes more and more parched, the

streamlets occasionally met with in the gullies during the other monsoon soon dry up; while the few streams in the neighbourhood dwindle down to a low ebb; the verdure which clothes the parched soil gradually loses its freshness, becomes scorched, and ultimately withered; the grass loses its succulence, and, lacking nourishment and water, domestic animals like the sheep, ox, &c., unless carefully tended, become thin and wasted. With a climate hotter, more oppressive, weakening, and less healthy and pleasant to the mere traveller than during the south-east breeze, the north-west monsoon season is far more enchanting to the naturalist and enlivening to the lover of the beautiful in nature; who may then revel amidst life of every form and hue; nor fail to find, in whatever direction his predilection lies, a fruitful field for his energies.

Among the causes which influence or modify the climate of Somerset and the region of which it is the centre, and distinguish it from that of places in a similar latitude whether on this or on the other side of the equator, the following are the most important.

1st. Influence of the sea. Nowhere around the entire circuit of the globe does the thermal equator take a greater bend than to the north of Australia; which indeed is the only region in which it lies to the south of the Physical equator. About Java it reaches its southernmost limit; and the reason of this is obvious. Over a large part of the globe the heat of the land, the mass of which lies in the northern hemisphere, causes the temperature of the latter to predominate as a rule. Hence the thermometric or thermal equator lies for the most part in the northern half of the globe, extending sometimes to lat. 15° N. In the wide Pacific the balance of caloric is in favour of the ocean, the heating power of which predominates and causes the equator of heat to bend well into the southern hemisphere where the great mass of water lies. Again, while it curves as far north as the equator opposite Papua, where the land has again a local predominance, we find that in the island-studded seas that lie between that island and Java, it bends well to the southward, viz., to about lat. 8° S. Here, although the warming influence of Asia must be great, this is more than counterbalanced by the effect of the sun on the shallow inter-insular seas now alluded to, which necessarily heat sooner and more highly than the deeper Pacific and Indian oceans; and by solar action on the Australian continent to the southward. That this is the true explanation is proved by the fact, that the isothermal equator followed westward takes a very large bend to the north as soon as we pass Java and get out of the influence of Australia and this confined sea; and into a region where the unmodified

effect of the extensive continent of Asia is permitted to come into full play. The experiments previously given go far to prove that the average annual temperature over a wide extent of shallow water like that which lies between and around the numerous islands of the Indian Archipelago and Northern Australia, may be raised above that of a similar extent of land in the same latitude, while the aerial currents over them are also modified; and to this, the alternately ascendant heat of the land and sea, are we to ascribe the frequent morning and evening calms; the augmenting afternoon breezes of the south-east monsoon; and the more prolonged and frequent inter-pluvial calms of the rainy season at Cape York. The heating influence of the solar rays on the shallow inner Barrier-reef route which runs along north-east Australia from 15 to 30 miles off the land, has a corresponding though more local effect on the winds of this coast in modifying the south-east trades and making them in certain regions give temporary place to morning and evening sea and land breezes. To the proximity therefore of Cape York to the Pacific, and especially to the inter-insular seas now alluded to, are we indebted for its high annual average temperature, and also for the comparatively great heat of the wet north-west monsoons when the temperature rises to 90° Fahr., and the winds blow over and from this region. High though the average annual temperature of Somerset therefore is, it is considerably under what it would be, were it not for two other influences: the first of which is, the prevalence of the cool dry south-east ocean winds during eight or nine months of the year, and the second is the proximity of the adjacent seas, viz., the Coral Sea and Pacific on the east, the Arafura Sea and Gulf of Carpentaria on the west, and Torres Strait on the north; conjoined with the narrowness and limited area of the pointed northern extremity of the Cape York peninsula. Were it not for this the average annual temperature of Somerset would be higher than it is; and more like that of Port Essington, which though in the same latitude 600 miles further west, is 5° Fahr. higher. Under similar influences, viz., proximity to the sea, to a cold coast current, and a lofty mountain range (Andes), the average annual temperature of Callao and Lima, situated in about the same latitude but on the opposite side of the Pacific, is 5° under that of Somerset; and again it is to its vicinity to cooling and equalising seas that the average annual temperature of Batavia, situated much nearer than Somerset, and indeed close to both the thermal and physical equators, is the same as that of the latter place. These influences combine not only to lessen the temperature of Somerset and its vicinity; but also to make it more equable, and to diminish both its annual and daily range.

It is to proximity to the Gulf of Carpentaria that we ascribe much of the rainfall of the hot season at Somerset. Rain is frequent with south-west winds that come from the shallow and highly-heated gulf-region. Originally humid north-west winds they here become super-saturated, and at the same time deflected, from a previously explained cause. Again, it is to proximity to the wide Pacific, combined with the influence of the sun's rays on the immense dry barren interior of Australia that we are indebted for the south and south-east winds common during certain seasons along the coast of New South Wales. Coming from the sea they are highly moisture-laden and often accompanied by rain or fog.

2nd. Currents and tides. The principal ocean current of the South Pacific is an easterly one which originally forms part of a much larger that comes from the Antarctic Ocean, and divides into several smaller streams to the west of Cape Horn. Originating in the south frigid zone its waters are at first cold; but turning westward about 95° w. long. and 25° s. lat., they get gradually heated as they flow among the myriad islands of southern Polynesia: until, passing the New Hebrides and New Caledonia, it breaks into two, of which one branch runs southward along the east coast of New South Wales; while the other, under the name of Rossel's drift, takes its course through the Coral Sea and the narrow-funnel-like opening of Torres Strait where it forms a one-knot current. Warmed in its lengthy circuit of several thousand miles among the waters of the South Pacific in the latitude of 20° to 23° s., especially during the north-west monsoon of Cape York when the sun is in the southern hemisphere and overhead; it has become a warm current ere it reaches Cape York, where, as already shown, its temperature is usually within a few degrees either above or below that of the air. This current doubtless serves slightly to raise the average annual temperature of Somerset; but it unquestionably has a still more important equalising effect on the climate; and to this we must partly ascribe the comparatively limited range of temperature both annual and diurnal. Strong tides run through Albany Pass and Torres Strait, say from $1\frac{1}{2}$ to $4\frac{1}{2}$ knots either way. The westward is the stronger, being aided by Rossel's drift. The influence of these tides on the climate is not very apparent; but it is probable that they have a cooling effect; and act by mixing the surface waters as they heat, with the cooler layers below, so as to reduce their temperature and indirectly that of the air; and at the same time equalize both. If no such tides existed we can readily conceive how warm the shallow waters in these regions would become; how hot the air over them; and how sultry the climate. Thus the

effect of the currents and tides of Torres Strait, though somewhat like that of the adjacent seas, is not shown in a very marked manner, or readily specialized; and is directed not so much in raising the temperature of the air and the prevalent winds as in rendering them equable.

3rd. Prevailing winds. Although often very irregular near the coast, especially towards the south, and often supplanted by sea and land airs or variable winds as far north as Rockingham Bay; the influence of the south-east trades which blow from Cape Capricorn northward, in reducing the temperature and humidity, and generally modifying the climate of the whole of the north-east coast of Australia, is very marked. Coming cool and moisture-laden from the South Pacific, they render the summer season enjoyable; and to them are we indebted for the showers which then prevail, and the heavier rainfall of the winter season, without which this region would be parched and barren. While without the cool south-east winds that prevail from Cape Melville to Torres Strait and blow with greater force than the latter, of which they are merely an exaggeration, the temperature of Somerset would be much more oppressive and unhealthy than it is. Even though highly saline and humid, contrasted with the still moister north-west monsoons, it is comparatively a dry wind, which rapidly evaporates perspiration, and thus conduces much to personal comfort. Remove out of this breeze, and the heat becomes oppressive and stifling, especially in the full glare of the sun: whereas in the shade, as this wind blows freely by, the atmosphere feels pleasantly cool and enjoyable. It is their temporary cessation during the morning and evening calms of this coast that makes their value in cooling the climate most apparent. The opposite effect of the sultry and humid north-west winds and their intervals of calm in rendering the temperature of Somerset and its vicinity hot, stifling, moist, debilitating, and unhealthy, is too evident to need comment. The influence of the sea and land breezes which prevail from Rockingham Bay southwards, on the temperature and salubrity of this coast, is also very marked; inasmuch as they aid in lowering the former and in raising the latter.

4th. The Physical Geography of Australia as a whole and of the Cape York peninsula in particular, materially influences their climate, especially as to temperature winds and rainfall. To the great heat of the extensive, comparatively flat, and rainless interior of Australia is due the hot "southerly busters" of New South Wales, and the "Brickfielders" of Melbourne, both prevalent during the summer season; the former having as their name implies a general south or south-west direction, and the latter a north-west one; which points to the overheated

interior as their source. So the hot and dry westerly winds, that not unfrequently prevail in New South Wales, have the same origin. While again the hot and dry south-west winds of the Albert River district and country bordering the bottom of the Gulf of Carpentaria, and that which forms the western part of the base of the Cape York peninsula as far north as the Mackenzie River, blow likewise from the superheated interior. Further north, an opposite effect is observable: for there instead of a scorched rainless interior to heat and dry the winds, we have in the Gulf of Carpentaria a wide and shallow sheet of water which both raises the temperature and loads the air with moisture, and increases thus the amount of precipitation. The main mountain range of Eastern Australia also influences in no small degree the meteorology and climate of this coast and peninsula. Coming in contact with its cool summits from 2000 to 3000 feet high, the south-east and east moisture-laden winds from the Pacific have their damp precipitated principally over its eastern side, while deflected to a more northerly course. Thus these winds are little felt in the region beyond; although the mountains are not sufficiently high to prevent them sweeping partly over, to furnish a limited rainfall to the western district and cool its temperature. The influence of this range is less marked in the south than in northern Queensland, and in the Cape York peninsula. The smaller altitude of the ridge in the extra-tropical regions, where rain falls all the year round, especially in winter, permits the moisture-laden breezes which bring it to blow well across and precipitate their moisture over a more extensive tract beyond, which has the larger Murray, Darling and other rivers to drain it; after which they sweep onwards over the low sandy interior as dry breezes. Further north the greater height of the range causes most of the moisture to be precipitated on the eastern slope, the result of which is that on the west a more limited tract is watered, and the rivers which drain it are few and of little consequence. Hence the parched often herbless character of the far interior which consists of sandy or stony deserts with occasional patches of scrub or stunted trees (tea-tree spinifex, eucalyptus, swamp-oak, desert-pea, &c.); all admirably fitted for a rainless region where vegetation is nourished by scanty dews or absorption from occasional half-dried streams and the shallow "creeks" or pools left in the deeper parts of their otherwise arid beds. Hence also the totally different character of the well-watered eastern and the badly supplied tracts west of this range; in the former of which vegetation is abundant. Those wide districts of undulating or nearly level pasture land that form the well-known grass-clad "Peak" and "Darling Downs," &c., the

finest squatting districts of Eastern Australia, lie on the flanks of this range. Although sufficient moisture is thus precipitated on the eastern slopes to water well the limited region which lies between their base and the coast; another cause makes its supply very irregular and either too copious or scanty. The short distance between their source and the Pacific, into which they flow, necessitates a rapid stream; and thus when rain falls they rise quickly and rush impetuously towards the sea; overflowing their banks, carrying trees, cattle, houses, and people in their course; flooding and devastating wide districts by destroying the crops. Carried quickly off the rapidly-sloping surface, the rain has no time to soak into the soil, which soon dries and does not retain its moisture like level country. Hence during the dry summer season, when rain seldom falls, we have long droughts lasting for weeks and even months, when the withered herbage that supplies scanty feed for the numerous flocks, and a scarcity of water, often sacrifice thousands of cattle, and prove more ruinous to the squatter than the floods of winter. Thus to this mountain range is chiefly due the fertility of the south-east settled portions of Australia; and further north that of Northern Queensland and the lower part of the Cape York peninsula, watered by the Burdekin and other rivers; and still further north that of Rockingham Bay and the well-wooded district beyond, as far as Cape Grafton. Its lessening height however in the upper two-thirds of the Cape York Peninsula renders the streams both few and unimportant. Hence the dryness of this region, its gradually decreasing fertility, and the peculiar vegetation which prevails as we approach Cape York, except along the borders of streams, where alone it shows a tropical luxuriance. The geological character of the east coast of Australia and Cape York Peninsula also materially affects the character of its climate. The non-retentive soils of New South Wales and Queensland, consisting of disintegrated volcanic rock, sandstone or shale, and beyond Cape Bathurst post-tertiary ironstone; and the hilly or undulating character and rapid drainage of the whole of this tract; are influences which more or less perceptibly affect climate, as they manifestly do the vegetation, by rendering the soil and superincumbent air dryer than they would be were the former clayey and more absorbent and the land more level. As it is, the winter rains soon dry up or run off, and hence the parched appearance of the northern end of the Cape York Peninsula during great part of the dry south-east monsoon.

The *Salubrity* of Somerset and its vicinity is a subject of no less importance than the nature of its climate; inasmuch as on this depends much its future as a field for successful settle-

ment; and the class and number of settlers likely to resort thither. Emigrants of European extraction invariably and wisely prefer a healthy and if possible a cool climate. If that of the region now under consideration is both sickly and sultry, it will probably influence the prospective population by leading to the immigration of Chinese, Malays, New Hebrides, and other South Sea Islanders accustomed to solar heat and exposure without causing inconvenience or running any risk to health; by whom heavy out-door work may be done. The insalubrity of Port Essington first led to the belief that intertropical Australia as a whole was unhealthy; an idea which that of the bottom of the Gulf of Carpentaria appears to confirm. There is little doubt however that this in the two places now named, arises purely from local causes and is exceptional. The spread of settlement of late years into northern tropical Australia appears to render a candid and unprejudiced estimate of the climate of Somerset necessary; and all the more so inasmuch as hasty deductions and prematurely formed opinions based on limited observation have already led to publicly expressed inaccuracy on the subject.

For at least 7 or 8 months of the year the climate of Somerset and its vicinity, and the entire eastern coast of the Cape York peninsula, is certainly fine *for a tropical latitude*. Though the temperature is high and the sun sultry where there is no breeze, the pleasant and often strong south-east monsoon which prevails and blows right up the Albany Pass, suffices to keep the atmosphere both of the anchorage and Somerset itself, which is also exposed to its current, pleasantly cool. No local influences exist to make the place peculiarly unhealthy, and, as far as yet seen, the climate at this season is remarkably salubrious for so low a latitude: and comparable only to that of Callao in nearly the same parallel on the opposite side of the Pacific, which differs in some important respects, yet resembles it in healthiness. It thus contrasts strongly with Port Essington, 600 miles further west. During the first six weeks (August and half of September) which followed the settling of this colony, no sickness occurred among the 120 men of H.M.S. *Salamander* who slept on board; or among the 30 marines and colonists camped on shore; although the majority of both were exposed for many hours daily to the full influence of the sun, and that often when working up to their waist in water in loading and unloading boats on a shallow beach. But this was evidently too favourable a season, and the period too brief to enable us to form a trustworthy opinion, especially as the men were fresh from the healthy climate of Sydney, and lately arrived from England with hale and hearty constitutions uninfluenced by long residence

in the tropics or exposure to other debilitating causes, and kept in good spirits by genial work and the exhilarating prospect of colonial pay. Longer experience has shown that its damp atmosphere is apt to induce rheumatism in predisposed subjects, and to enervate the weakly, and even the strong. The remaining four months which comprise the hot, rainy season, are both less pleasant and healthy; and although the young and vigorous may withstand, perhaps for some years, the debilitating influence even of this season, various complaints are apt to occur, especially among the weak, such as rheumatism both acute and chronic, while even the hale feel languid and listless. Though damp, the air during the south-east winds of Cape York is *comparatively* dry contrasted with the saturated atmosphere of the Gulf of Mexico, Bay of Panama, or Hong Kong harbour, while the strong evaporating breeze makes its humidity less apparent, and renders the climate at this season healthier than it would otherwise be.

Climate in the tropics is perhaps oftener a remote than an exciting cause of disease. Far more frequently, however, it is accompanied and intensified by other morbific agencies; and of these none is so common as malaria. When this is absent, a tropical climate may be remarkably salubrious to the European constitution, provided hygienic and other indications necessary to preserve health under such altered circumstances are fully and assiduously attended to. The climate of Somerset is an example of this. No malaria or other morbific influences beyond those of climate exist here, and the latter are materially diminished by the cool, bracing breezes of the south-east monsoon, which frequently last for nine or even ten months, and contribute much to strengthen and enable the system to withstand the weakening effects of the wet season. But with this limitation there appears reason to believe that the climate of Somerset is no exception to the great law that change from a cold to a warm climate is sooner or later productive of disease and mortality in the white constitution; the chief maladies apt to occur being fevers, affections of the biliary organs and alimentary canal. Nor are Europeans here exempt from the rigorous law of climate common to all mankind, viz., that the white races attain the most perfect health and longest life above 40° N. and 30° S. latitude, while serious physiological changes are liable to occur the nearer they approach the equator; health first suffers, and disease may ultimately ensue. Three years' experience of the effect of this climate on a detachment of 20 marines, and a few private settlers and government officials stationed here, and on the crew of H.M.S. *Salamander*, who

spent about four months of each year along this coast, fully corroborates what theory first led us to expect.

Thus, although several circumstances, such as geographical position, peculiar form, relation to the seas which bathe it, and the absence of geological and other physical causes of disease, all combine to render the climate of Cape York not only cooler and more pleasant, but also more salubrious than that of many other inter-tropical places in the same latitude; it should not be forgotten that it is a tropical climate after all, and though comparatively healthy and no active disease prevails, still it is, as with all torrid climes, unsuited for the prolonged residence of the white races, whose constitutions are adapted for a lower temperature, and for that only; and out of which, especially when they proceed to a warmer, their health slowly but surely deteriorates, although they may perhaps be fortunate enough to escape the more serious disease which a stay in all low latitudes is apt to occasion. The climatic effect observable in the 240 sheep taken north from Brisbane to supply the colony on its first settlement is interesting, and tends to support this opinion. Under the influence of the withered herbage of the dry season, a scanty supply of water, and the hot atmosphere, they diminished in bulk to an average of 25 lbs. each. After the advent of the wet season, however, and under the profuse succulent herbage which then rapidly springs up and clothes the parched country with a pleasing covering of bright green, they soon gained in weight. But, half-starved thus for eight months, and overfed during the remaining four, a result could not be expected otherwise than injurious to the breed both as to carcass and wool. This has been less apparent among cattle and horses, of stronger and perhaps more pliant constitution, doubtless from the briefness of the trial: and after an exposure of three years, it may now be regarded as proved that sheep at least, if not horses and cattle, do not thrive well, although, like Europeans, they may struggle through their existence in a latitude in which the herbivora never flourish. Thus the salubrity of the climate of this locality is only relative, and though genial enough compared with other tropical climes, and healthier by far than many, still, like all places situated near the equator, it is apt, and indeed certain, to enervate and weaken the European constitution after a more or less prolonged stay, and predispose to, if it does not actually induce, disease. All tropical climates are debilitating, and that of Somerset is no exception to the rule. Healthy it may be to aborigines born and reared here, and possessing systems adapted for and accustomed to torrid heat, but it is assuredly sickly for the white races of cooler

climes. Occasionally the young, strong, and healthy appear to flourish and even fatten for a time, but with the majority the reverse sooner or later happens; and probably when longer tried and better known, it will be found, as indeed it already has, unsuited and even dangerous for the prolonged residence of Europeans, and especially unfit for open-air work in the sultry sun; and further, that though the cool south-east monsoon is enjoyable enough for a warm climate and not specially insalubrious, the opposite humid and rainy season is more weakening and far less healthy. Even during the comparatively cool south-east monsoon, the heat and increased perspiration cannot prove otherwise than slowly debilitating; while in the wet season the cutaneous exudation, so copious as to keep the surface constantly bathed, is notably weakening and unhealthy. In proof of these opinions corroborative facts might be given, were they necessary or appropriate here.

XIV. — *On the Elevation of the Country between Bushire and Teheran.* By Major O. St. John.

The country traversed by the main road between the north of the Persian Gulf and the Caspian may be generally described as a succession of long valleys of inconsiderable breadth and various elevation, separated by parallel ridges running north-west to south-east.

On examination of the comparative height and extent of these ranges, they are found to group themselves into four systems or chains, of different physical aspect and geology, and with well defined watersheds.

After leaving the shores of the Persian Gulf at Bushire, a traveller skirts the hills in a northerly direction for 40 miles. He then crosses two inconsiderable ranges of tertiary formation, the summits of which are about 3000 feet above the sea, to the valley or plateau of Konartukte (1800 feet). The pass of Kotul Meloo, by which this last is reached is, though short, one of the most difficult in Persia, and many camels and mules are annually lost in the ascent of its formidable declivities. A somewhat similar, but less arduous pass, leads to the fertile valleys of Kammarej, Shapoor, and Kazerūn, 2800 feet above the sea. The hills hitherto crossed are composed of sandstone of loose texture, marls, and gypsum. At Kazerūn we enter the great series of saddle-shaped hills of nummulitic limestone, which is the great geological characteristic of this part of Persia.

Up to this point the scanty vegetation is confined to ragged